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Eight papers focus on strategies for educational planning. In "Policy Formulation and Policy Implementation Relationships in an Educational System," Donald Miller asserts that performance relationships can be explained in terms of an educational system and its environment. Arnold Reisman and Martin Taft present "A Systems Approach to the Evaluation and Budgeting of Educational Programs." Richard Goodman examines the PPBS approach in "PPBS: Challenge to Educational Planners." Marvin Hoffenberg considers program budgeting for school system management in "Program Budgeting in Education: Some Organizational Implications." Richard Kraft examines the role of the educational planner in "Changing Manpower Needs and Educational Obsolescence: Implications for Vocational-Technical Education Planning." Desmond Cook discusses three "Economic Considerations in Educational Project Planning." An economic analysis of tomorrow's school is presented by C.W. McGuffey in "Economic Planning for the Future Development of Educational Facilities." Robert Campbell contrasts the economic approach to educational demand analysis with other approaches in "Approaches to the Analysis of the Demand for Higher Education: A Tool for Educational Planning." (HW)

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STRATEGIES OF EDUCATIONAL PLANNING

Richard H. P. Kraft

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**EDUCATIONAL SYSTEMS
DEVELOPMENT CENTER**

florida state university

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florida state university

The objective of the Educational Systems Development Center is to apply the quantitative-scientific technology of systems analysis and operations research to educational problems.

In the pursuit of this objective, the research efforts within the Center consist of joint projects with school systems. Major effort is expended in those areas which carry the labels of systems analysis, operations research, cost/utility, program budgeting, organizational structure, and management information systems.

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STRATEGIES OF EDUCATIONAL PLANNING

**PROCEEDINGS OF THE
SECOND ANNUAL CONFERENCE ON
THE ECONOMICS OF EDUCATION**

Edited by Richard H. P. Kraft

**Sponsored by the Educational Systems
Development Center, College of Education
The Florida State University
Tallahassee, Florida**

1969

Educational Systems Development Center

Preface

The conference on Strategies of Educational Planning, held at The Florida State University, in Tallahassee, Florida, on July 31, 1968, was the second in a series of symposia sponsored by the Educational Systems Development Center.

The purpose of the conference was to point out the directions that have been taken and that might be taken in a systems approach to educational planning.

While planning the conference and during the preparation of the proceedings, many people have provided valuable comment and constructive criticism. First and foremost, I am indebted to the authors themselves. Without their hard work and scholarly dedication to the assigned topics, neither the conference nor this book would have materialized so successfully. Carrying the planning process forward, Mr. Ned Lovell assumed the leadership as coordinator.

Particular acknowledgment is due to Professor Frank W. Banghart, whose incisive mind influenced the editing phase and to Miss Wilma Smith and Mrs. Karen Wilson for a variety of significant contributions, including typing, proofreading and general assistance in the preparation of the manuscript.

Richard H. P. Kraft

October 1968

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Part One

Systems Analysis in Educational Planning

Introduction

Richard H. P. Kraft

The Educational Systems Development Center is pleased to publish the proceedings of the Second Annual Conference on the Economics of Education, which was held at The Florida State University in July, 1968.

The Center feels that this continuing series of conferences serves a number of purposes. It is in keeping with the objectives of the Center to develop practical guidelines for helping individual school systems to strengthen educational planning. The symposia also help to examine critically the experiences of educational planners in all parts of the United States. The main concern of this year's conference was to build appropriate strategies for educational planning.

Eight papers were commissioned for the Conference. The first speaker, Donald R. Miller, addressed himself to the performance relationships that can be shown to exist between an educational system and its environment. Miller's view is that a general pattern of performance relationships is related to policy decisions and can be explained in terms of system inputs, product development, system outputs and product performance effectiveness. Policy decisions can, in turn, be related to culturally based values, social expectations, performance requirements and terminal products of the educational system.

The speaker noted that:

The dominant values held by key functionaries in the cultural environment of an educational system generally are reflected in the decisions and judgments made by policy-making bodies in that environment. The values assigned to educational system performance and products by environmental judges [are] proportional to their perceptions of the benefits realized by society through effective product performance.

The environment of an educational system exerts continuous policy-making influence upon educational system management by specifying performance requirements and defining the desired outcomes of performance. Institutionalized patterns of system performance also exert continuous influence upon management decisions. Thus, policy decisions requiring change are generally backed by positive influence from the environment, but they can be expected to experience some negative influence when implemented in the system. Management must attempt to maintain a delicate balance between these continuous sources of influence in an effort to manage system performance in such a manner that the system will efficiently and effectively achieve its objectives and fulfill its requirements.¹

Miller concluded that:

Primary attention must be given those generic-system environment relationships which are affected by, and which in turn affect, policy decisions. An analysis of these relationships will improve [the] basic understanding of such relationships and enable [the educational planner] to specify other relevant relationships.²

The following paper presented a systems approach to the evaluation

¹Donald R. Miller, Policy Formation and Policy Implementation Relationships in an Educational System. An abstract from a report to the Second Annual Conference on the Economics of Education, Tallahassee, July, 1968 (Tallahassee: The Conference, 1968).

²Ibid.

of educational programs. Arnold Reisman and Martin I. Taft, the two speakers who delivered this joint presentation, argued that, although a dialogue has been initiated

. . . between operations analysts and school administrators, most of the operations research work in education has addressed itself to the analysis and/or implementation of alternative programs and policies assuming that the value system of the institution is known. [Their] paper [was] an attempt at bringing operations research methods to aid in the setting of goals, objectives, the utilities, and the criteria of evaluation of educational programs.

It represents an integration of concepts from the utility theory of economics; criterion function theory from engineering design; decision and subjective probability theories; and the Delphi methodology for arriving at a consensus of opinions for the purpose of identifying and evaluating the goals, the objectives and their attainment within various educational establishments and/or programs. The methodology is aided by Fortran II and Fortran IV computer programs; the latter was designed for use in a time-sharing mode.¹

The third contribution which was given by Richard H. Goodman examined the PPBS-approach. He suggested that:

The crisis in public education must be met head-on by educational planners. One tool that will help is in use in industry and government: PPBS. Planning, programming, budgeting systems will help bring about the necessary revolution in American education if planners will work at developing this concept in terms of the needs of education.

Education is a combination of many systems. The challenge before educational planners is to analyze each system in relation to its impact on the learner and its interrelationship with other systems.

¹Arnold Reisman and Martin I. Taft, Evaluation of Educational Program: A Systems Approach. An abstract from a report to the Second Annual Conference on the Economics of Education, Tallahassee, July, 1968, (Tallahassee: The Conference, 1968).

The lack of dollars and the need for better schools require school leaders to develop new approaches to the job of financial management.¹

Marvin Hoffenberg considered program budgeting to be a "new informational environment" for the management of a large complex organization; e.g. a local school system. He pointed out that:

Possible implications of program budgeting on the system cannot be isolated from other intellectual and social forces impacting local educational practices and choices. The local school district is viewed [by him] as an open system constantly interacting with an environment, with changing inputs and outputs and varying systemic states. Decision-making in this system is institutional decision-making and program budgeting [thus has to be] analyzed within an organizational decision process. [Hoffenberg outlined the] role and limitation [of program budgeting] as a framework for adversary proceedings and conflict resolution. . . .²

The speaker then focused on the objectives of a planning-programming-budgeting process

. . . to ensure that action follows policy; to improve the information on which to choose between one program and another; and, much more modestly, to guide the distribution of resources between one field of policy and another.³

The paper by Richard H. P. Kraft examined the role of the educational planner as "Manager of Change." Kraft developed the thesis that the

¹Richard H. Goodman, PPBS: Challenge to Educational Planners. An abstract from a report to the Second Annual Conference on the Economics of Education, Tallahassee, July, 1968, (Tallahassee: The Conference, 1968).

²Marvin Hoffenburg, Program Budgeting in Education and the Management of Local School Systems. An abstract from a report to the Second Annual Conference on the Economics of Education, Tallahassee, July, 1968, (Tallahassee: The Conference, 1968).

³Ibid.

educational planner-administrator needs strong

. . . predictive quantitative models, suitable for testing, having cross-technology capability and linking technology with economic feasibility.¹

These could be used to identify long-term technological changes.

The speaker felt that not all administrators seem to be willing

. . . to consider and be constrained by the requirements of the occupational end-use of their products. The problem, then, is how to develop a system or set of sub-systems which would facilitate the syndromization of occupational requirements and occupational-technical education planning objectives.

. . . existing automated counterparts as substitutes for human control and communication processes [were] discussed in relation to technical education planning. [It was noted that they] may provide the planner-administrator with the basis upon which to build predictive instruments for future changes in occupations. The social demand approach to educational planning [was] emphasized by contrast with economic analyses and operations research methods.

To the extent that recent technological developments emphasized the need for long-range planning, a systems look as [used in the presentation] may provide a methodological basis for interdisciplinary, planning-oriented research. Work in progress at the Educational Systems Development Center at the Florida State University dealing with the social demand approach to educational planning, [was] described in reference to [changing manpower needs in Florida].²

Kraft concluded with comments

. . . on the possibilities and limitations of vocational-technical education planning and its integration in a broader framework of social planning.³

¹Richard H. P. Kraft, Changing Manpower Needs and Educational Obsolescence: Implications for Vocational-Technical-Education Planning. An abstract from a report to the Second Annual Conference on the Economics of Education, Tallahassee, July, 1968, (Tallahassee: The Conference, 1968).

²Ibid.

³Ibid.

Desmond L. Cook discussed three

. . . selected situations in educational project planning which involve consideration of the cost or dollar factor as well as the time and performance variables. The three situations involve (a) the development of alternative plans for presentation to the resource allocation decision-maker, (b) the need to consider termination of unsuccessful projects as an economic problem, and (c) the impact of successful research efforts on long-term funding commitments. [Cook] developed [the thesis] that education can benefit from the experience of the government-military-industrial complex with regard to resource allocation to project situations of the type discussed.¹

The next paper presented an economic analysis of the "School of Tomorrow." C. W. McGuffey offered a number of comments on the ever-growing need for school housing. He pointed out that:

Population change reflected in the form of increased numbers and greater mobility, the rapid discovery and creation of new knowledge and the acceleration of automation create unpredictable changes for education. Sociological changes in our society will likewise affect education in yet unpredictable ways.

It is apparent that the need for school housing will be accelerated due to these above factors and to the built-in obsolescence of existing structures.²

McGuffey presented the nature of the obsolescence of existing structures in relation

. . . to factors considered critical to the economic planning of school buildings. Factors of obsolescence are considered the objects of the continual search for economical planning.

¹Desmond L. Cook, Economic Consideration in Educational Planning. An abstract from a report to the Second Annual Conference on the Economics of Education, Tallahassee, July, 1968, (Tallahassee: The Conference, 1968).

²C. W. McGuffey, Economic Planning for the Future Development of Educational Facilities. An abstract from a report to the Second Annual Conference on the Economics of Education, Tallahassee, July, 1968, (Tallahassee: The Conference, 1968).

The elimination of the potential for early obsolescence is essential if the wise use of resources is to be achieved.

The economic planning for school buildings should be concerned with the creation of school facilities which meet desired environmental goals, provide adequately for today's educational requirements, have the potential for change to meet tomorrow's needs and at the same time, utilize a minimum of available resources. Educational, architectural and economic planning [were] viewed as inseparable elements in the total process of planning adequate school buildings for the future.¹

Summarizing his comments, McGuffey viewed the school building of the future as a

. . . structure with a minimum of interior partitions, loaded with electronic gear and planned for highly individualized instructional activity. Space for group processes and democratic action will also be provided to enhance the socialization of pupils. Its structure and envelope will be architecturally planned using prefabricated modular components.²

The last presentation brought another important research area to the foreground. Robert Campbell contrasted the uniquely economic approach to demand analysis in education with other related approaches most of which are asserted to be

. . . "demand" explanations. These include empirical studies of aggregate public expenditures on education, the determination of demand requirements in planning models, and socio-psychological studies of individual educational aspirations and plans. All can be related to the problem of forecasting college enrollments. It is argued, however, that the rational decision model of demand provided by economic theory can make a useful and unique contribution to the economics of education.

¹Ibid.

²Ibid.

The two principal approaches to the economic analysis of educational demand [were] then examined: the one viewing education as an investment good, the other treating it as a consumer good. The problem of distinguishing these two characteristics of the educational product and testing hypotheses based upon them, and the more general problem of defining the product of education [were] discussed in relation to the special characteristics of higher education.¹

Campbell concluded with critical comments on the limitations of higher education planning and the role that demand studies might play in it.

Finally, the question should be asked, What impact did this conference have? Certainly no burning problems have been solved, nor have many questions been answered. If, however, the participants and the contributors have felt the necessity for maintaining a dialogue, if those present are now convinced that educational planning must become a more central and effective instrument, and that planning must permeate the entire administrative and educational process, the conference presumably has achieved its objective, i.e., to build strategies for educational planning.

¹Robert Campbell, Approaches to the Analysis of the Demand for Higher Education: A Tool for Educational Planning. An abstract from a report to the Second Annual Conference on the Economics of Education, Tallahassee, July, 1968, (Tallahassee: The Conference, 1968).

Policy Formulation and Policy Implementation Relationships in an Educational System

Donald R. Miller

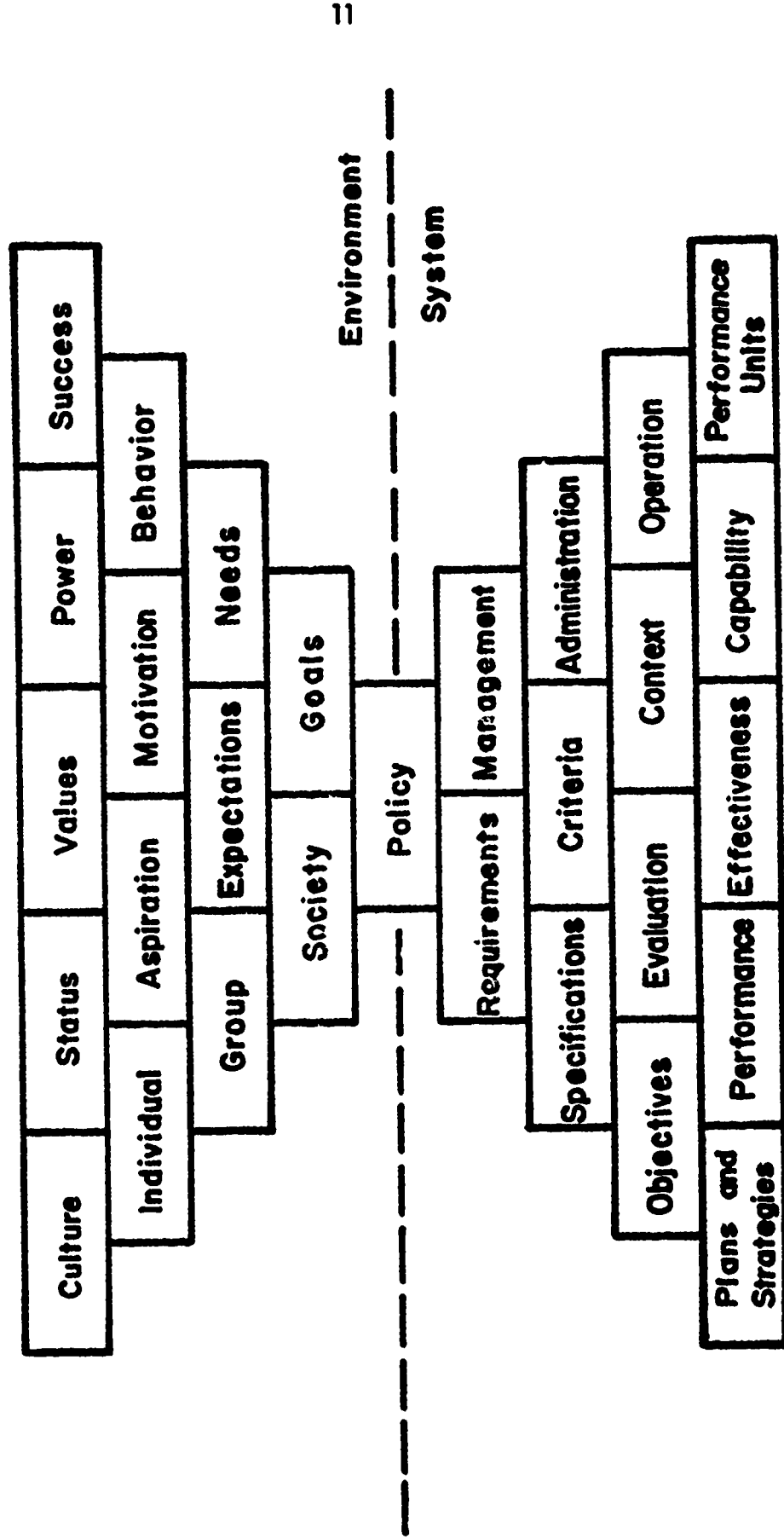
INTRODUCTION

An educational system has its basis in the cultural environment from which it is organized. Generally, culturally-based systems are conceived, established, organized and maintained to provide differentiated services and/or to perform specialized functions for society. As such, a culturally-based system can be regarded or studied as a context of a larger system or environment. The term "system" is, therefore, generally made relative to the principal gestalt under consideration. Any designated portion of that gestalt can be defined as a functional and organizational context of the system.

A system has both an external and an internal environment. The term "system environment" is assigned to that portion of the gross environment which exists within the boundaries and dimensions of the system. The larger context to which the system can be related is called the "environment." The environment includes all external and system-environment interface situations and conditions which effect the system at any stage and/or in any state of its existence. Generally, a consistent set of characteristics can be defined to explain both the system and the environment.

One of the common characteristics of an educational system and its environment is the policy decision. Policy-decision

Policy-Formulation and Policy-Implementation Relationships Figure 1



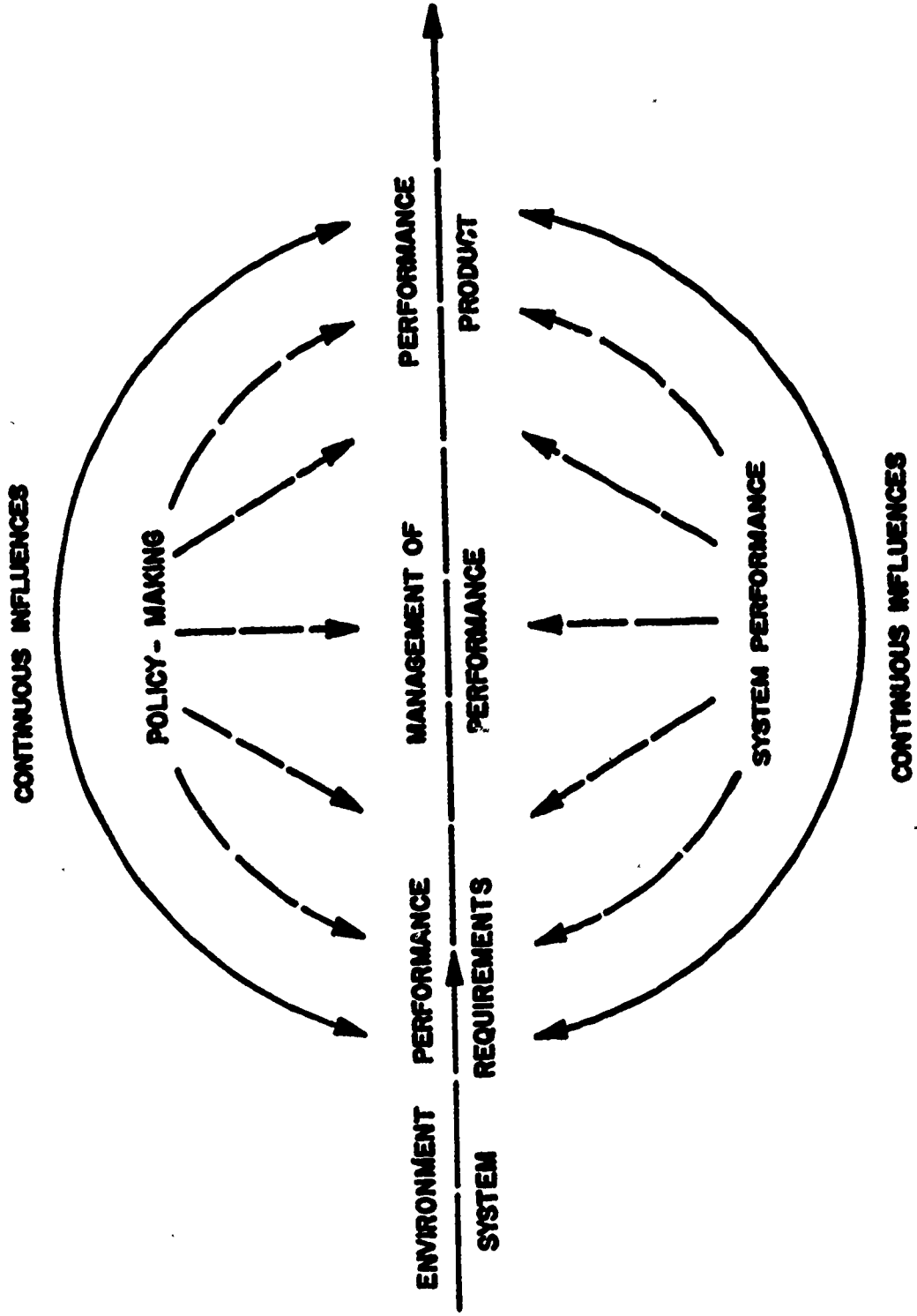
relationships can be specified to exist between the system and its environment. An analysis of these relationships will provide needed dimensions of understanding for specifying additional educational system-environment relationships.

FIGURE 1 specifies the policy formulation and policy implementation relationships which exist between an educational system and its environment; especially, when the policy-making body is representative of the environment. The upper part of the model relates to decision antecedents which influence policy-formulation processes. The lower part of the model relates to subsequent management policy-implementation procedures. Each area of the model will be discussed in terms of its relationship to policy formulation, policy implementation and management.

The environment can be regarded as exerting continuous policy-making influence upon the management of system performance by specifying performance requirements and defining the nature of performance and/or performance products as suggested in FIGURE 2. This model also suggests that institutionalized patterns of system performance also exerts continuous influence upon management decisions. Thus, policy decisions requiring change can be expected to experience some negative influence when implemented in the system. Management must attempt to maintain a delicate balance between these continuous sources of influence in an effort to manage

A MODEL OF PERFORMANCE INFLUENCE

FIGURE 2



system performance in such a manner that the system will efficiently and effectively achieve its goals and fulfill its requirements.

THE EFFECT OF THE CULTURAL ENVIRONMENT ON POLICY FORMULATION¹

A logical starting point in a discussion of the cultural environment of an educational system is with the definition of culture. As it will be used, culture is the organization of values, norms and symbols which affect the choices made by individuals and which determine the types of interaction that may occur among the individuals. It provides a pattern of organization whose different parts are related to form value systems, belief systems, and systems of expressive symbols. No individual can create a culture; it is always shared by relatively large groups. The culture functions as a modulator of both the evolutionary growth and development of society and the changes which occur within society's pattern of organization. Another central function of culture is the legitimation of society's normative order.

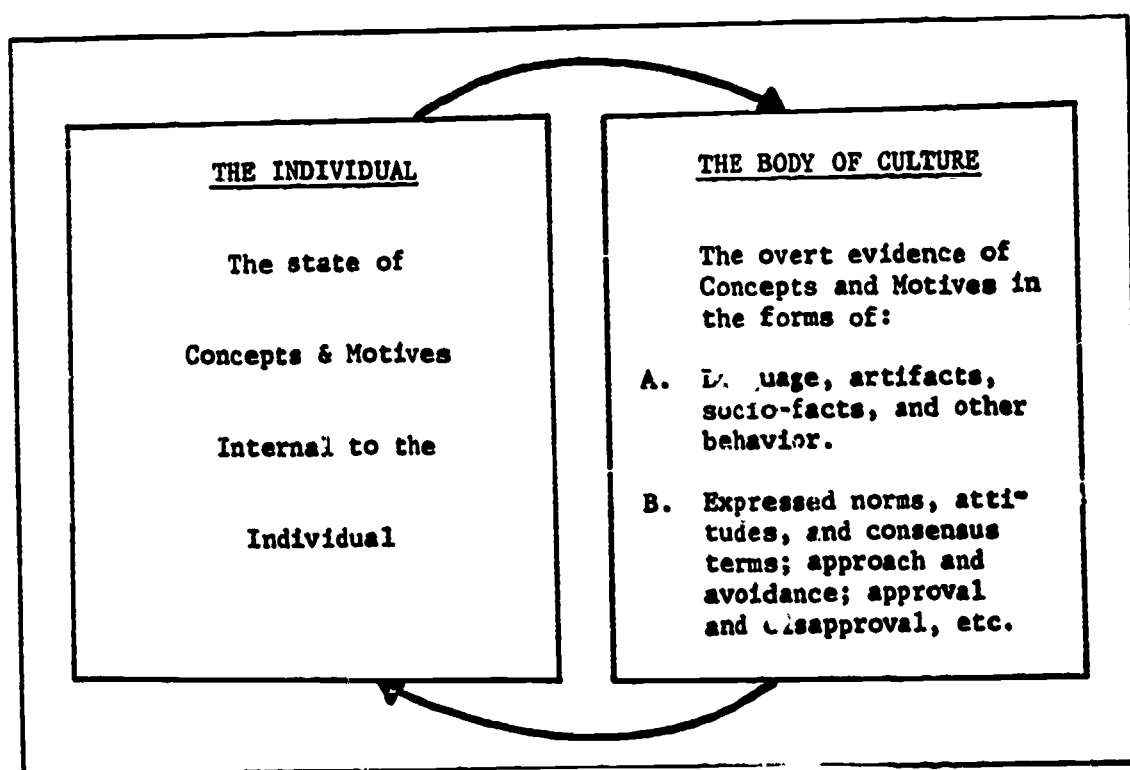
Alfred Kuhn contributes to an understanding of culture through his conceptualization of it as a system. "Culture is both a body of content and a set of relationships. Both the

¹Principal credit for the development of this section belongs to Sandra Mayer of the Staff of OPERATION PEP.

content and the relationships depend on the ability of the human beings to communicate, and to engage in related behavior. . . ." ¹

Kuhn's concept contends that the culture is the human environment into which the human being is born, and from which he learns about interpersonal behavior. Kuhn's concept of culture as a system is presented as FIGURE 3.

THE SYSTEM OF CULTURE ²



¹Alfred Kuhn, The Study of Society: A Unified Approach, (Illinois: Richard D. Irwin, Inc., 1963), p. 205.

²Ibid, p. 206.

The first part of the system is the cultural envelope which surrounds each individual and molds him into its own image. The second part of the system is the influence of the individual on the culture. This mutual interaction of the existing culture on the individual upon the body of the culture constitutes the "system of culture." Thus, the cultural system is a self-perpetuating vehicle of change and adaptation which facilitates the transmission of knowledge and technology from generation to generation.

This conceptualization and definition of culture provides a basis for the discussion of relevant cultural elements. Every person within a given culture is enmeshed in a multitude of social relationships which together form a network. To view the individual as a person occupying the center of such a network, the center on which all his concrete relationships converge, is to locate his position in society, usually called his status.¹

More specifically, status is one's position in society; the standing accorded the individual by his fellows; one's place on the prestige scale; and one's personal orientation in his cultural setting relative to the generalized set of values held by those making the judgment.

¹Kurt Lang and Gladys Engel Lang, Collective Dynamics (New York: Thomas Y. Crowell Company, 1961), p. 6.

According to Talcott Parsons, the main point of reference for analyzing the structure of any social system is its value pattern.¹ This value pattern establishes the basic orientation of the system in the operational situation and hence guides the activities of individuals. Expressed in general terms, values are the desirable end states which serve as a guide to human endeavor. They are so general in their reference that they do not specify sets of norms, types of organization, or kinds of facilities which are required to realize these ends. The value system legitimizes society's goal, but effective goal attainment requires the exercising of available power.

Power is defined as the generalized capacity for individuals to mobilize resources in the interest of attaining specific goals. The resources and goals may be social, political, and/or economic in nature. Furthermore, activation of an individual's capacity to mobilize resources is largely determined by his perceptions of the goal(s), relevant values, and his social status in relation to these values and goals.

As the existing cultural system evolves, changes occur in the dominant value pattern as a result of the continuous exercising of power by individuals within the culture. At a point in time,

¹Talcott Parsons, Structure and Process in Modern Societies, (New York: The Free Press, 1965), p. 20.

therefore, success is a measure of change; measured by degree, rate, type, direction, and/or commitment, and the favorable termination or attainment of an end state relative to values. The further an individual is required to go to experience success, the more power he will necessarily be required to exercise in its achievement.

Up to this point, the concepts discussed have been on a rather abstract level. Again, we must remember that the principal focus is upon policy making, and that the preceding discussion of environmental elements was presented in an effort to establish that focus.

The "individual" within a culture is generally taken for granted with respect to the impact he has on cultural evolution. It is only through an understanding of the individual and the nature of the changes occurring in him over a period of time that one can understand the evolution of a cultural system. The individual is the primary unit of structure and function in society---a single human being as contrasted with a group of several human beings. An individual, within a culture, experiences evolutionary growth and development which is constrained by his life environment and which is limited by his basic pattern of inheritance.

The individual is strongly influenced by the status position afforded him by his peer group and what he perceives as his status position. Each carries aspirations for the attainment of a certain goal or goals. By aspiration we mean a strong desire to achieve certain goals. The values held collectively by a group of individuals within a given cultural system determines the goals, either directly or indirectly, and thereby positively sanctions desires for its attainment. Conversely, a goal set by another group may stimulate negative sanctions.

The presence of positive and negative sanctions, together with perceptions of their effects, determine the direction of an individual's actions. The motivation varies with the situation and also varies in intensity as perceptions vary with respect for the sanctions. Motivation is defined as the process of arousing, sustaining, and regulating a person's conscious or unconscious expenditure of energy to act in a certain way to reach a specified goal. The process is influenced by perceptions of positive and negative sanctions (rewards and punishments) based on inherent values; and by the system of constraints experienced by the individual while making a decision to act.

Bunker expressed the relationship between aspiration, motivation, and values very clearly. He stated that the strength

of a particular motive tends to be stable over a long time span, but the readiness to act in a particular way with respect to that motive varies with the situation. "A motive is aroused and becomes operative only when a person's cognitive field includes an expectancy that the performance of some act will lead to the attainment of the goal of the motive."¹

The behavior of an individual is the characteristic way he acts. These acts are generally oriented toward the attainment of ends or goals or other anticipated states of affairs. Such acts can be described and specified both quantitatively and qualitatively. They take place in given situations and are influenced by conditions which are indigenous to such situations. Acts are normatively regulated and they involve motivation, expenditure of effort, and the experiencing of consequences. The behavior incumbent upon a person in a given status defines and is defined in turn through his relationships with persons in other status positions. Behavior may also be defined in terms of the perceptions and the expectations of other people relative to performance requirements in the attainment of goals. Such performance can be made relative to the characteristic actions,

¹Douglas R. Bunker, "Human Inputs," in John A. Seiler, System Analysis in Organizational Behavior, (Illinois: Richard D. Irwin, Inc., and The Dorsey Press, 1967), p. 62.

patterns, structures, and the alternative ways of acting in the cultural environment.

The strength of a tendency to act in a particular way at any given point in time is a function of the stable strength of relevant motives, the strength of the expectancy that the act would achieve the desired results (success), and the magnitude of the anticipated value-oriented incentive. Bunker illustrated this using the following formula:

$$\text{Motive Strength} \times \text{Expectancy of Goal Attainment} \times \text{Magnitude of Incentive} = \text{Effective Motivation To Behave}$$

Individuals generally act and react in collectivities or groups sharing common interests and desires. The nature of the continuous interactions occurring between members is determined by a set of statuses which define the relatively stable relationships that people in various positions have with each other and with the group. Such relationships are established and maintained with due regard for the generalized pattern of values collectively held by the group members. The members of the group operate within definable boundary conditions. If boundary conditions are flexible, then the sphere of action is relatively large. However, as boundary conditions become more rigid the sphere of action

¹Ibid., p. 63.

becomes more limited. The members of a group will collectively accept changes in boundary conditions within a certain range of tolerance. However, when the minimum threshold of tolerance is violated, the group will establish rigid minimum territorial boundary conditions which they will fight to maintain.

Traditionally, groups establish expectation levels of achievement for individual members and for the group as a whole. Expectation can be expressed as a measure of success anticipated in the attainment of a given goal or end state. Expectations that are achieved by the individual or group tend to motivate further aspirations for attainment of goals which, in turn, influence behavior. The relationship is circular always leading toward goal attainment.

Behavior is motivated by an individual's perception of needs. At a given point in time, a need can be defined as the identifiable differential that exists between "what is" and "what should be" in a specified behavioral system relative to some aspect of defined behavior and relevant values. The effect which these conditions have on an individual or a group depends upon the perceived intensity of the need and upon the fluidity of relevant aspects of their respective cultural and life environments. The need may be satisfied by attaining a desired goal or attaining a goal that has been substituted during the process of attainment.

Throughout this discussion we have used the terms society and goal frequently. The network of human relationships called society can be defined as a collectivity of groups characterized by purposive action which is dependent on the reflective and voluntary cooperation of its members. A number of like-minded, value-sharing individuals or groups who enjoy their collectivity and are, therefore, able to work together for common ends within a defined framework for action. It is further characterized by a high degree of interaction between its members and member groups.

Finally, a goal may be defined as the object, conditions, or activity toward which the motive is directed and, once reached, will satisfy a need.

In summary, policy decisions reflect the generalized pattern of values existent within a given culture. In addition, policy decisions reflect the expectations and goals of society. Further, the behavior of individuals making policy decisions is normatively regulated in terms of these values, expectations, and goals.

POLICY IMPLEMENTATION AND MANAGEMENT

The implementation of policy decisions is the critical task of management. Realizing that the dominant values held by key functionaries in the cultural environment are generally reflected in policy decisions, management must develop performance procedures which are sensitive to these values. Through the establishment of value sensitivity, management creates an avenue to greater effectiveness. Thus, management procedures relative to policy implementation will be judged to be efficient and effective to the extent that they are consistent with the dominant pattern of values held by individuals in the cultural environment.

Policies

The decisions of legally constituted policy-making bodies comprise the critical information input for educational management at all levels of organization in an educational system. A policy is defined as ". . . a definite course or method of action selected from among alternatives and in light of given conditions to guide and determine present and future decisions."¹ Thus,

¹Webster's Seventh New Collegiate Dictionary (Springfield, Mass.: G & C Merriam Company, Publishers, 1967), p. 656.

policy decisions require consideration of alternative courses and/or methods of action and an appraisal of relevant present and future performance conditions.

To a significant extent, sound policy-formulating practices will provide quality assurance in future performance. Realizing that each policy decision involves selecting a course and/or method of action from among expanding sets of available alternatives, it is apparent that selection will be influenced by the total set of prevalent conditions and conceivable possibilities. Thus, policy decisions can be compared to hypotheses which are specified to guide performance in controlled scientific investigations.

John Dewey pointed out the significance of this experimental nature in his Logic:

. . . every measure of policy put into operation is, logically, and should be actually, of the nature of an experiment. For (1) it represents the adoption of one out of a number of alternative conceptions as possible plans of action, and (2) its execution is followed by consequences which, while not as capable of definite or exclusive differentiation as in the case of physical experimentation, are none the less observable within limits, so they may serve as tests of the validity of the conception acted upon. The idea that because social phenomena do not permit the controlled variation of sets of conditions in a one-by-one series of operations, therefore the experimental method has no application at all, stands in the way of taking advantage of the experimental method to the extent that is practicable Recognition of its experimental character would demand, on the side of its contents, that they be rendered as definite as possible in terms of a number of well thought out alternatives, or as members of a disjunctive

system. That is, failure to recognize its experimental character encourages treatment of a policy as an isolated independent measure. This relative isolation puts a premium upon formation of policies in a comparatively improvised way, influenced by immediate conditions and pressures rather than by surveys of conditions and consequences. On the other side, failure to take into account the experimental nature of policies undertaken, encourages laxity and discontinuity in discriminative observation of the consequences that result from its adoption. The result is merely that it works or it does not work as a gross whole, and some other policy is then improvised. Lack of careful, selective, continued observation of conditions promotes indefiniteness in formation of policies, and this indefiniteness reacts in turn to obstruct definiteness of the observations relevant to its test and revision.¹

The need to survey conditions and consequences in relation to policy decisions bear significant implications for management. The critical determinants in preferred consequence selection stem from ecological contexts which include communities of people living in particular environments each with unique conditions. The effect of policy is that it constrains performance with respect to preferred consequences. Thus, policy decisions are made to regulate activity to produce preferred or desired consequences. Environmental conditions have a direct effect upon the intensity of human expectations and the choice of values made to judge the effectiveness of achievement.

¹John Dewey, Logic: Theory of Inquiry (New York: Holt, Rinehart and Winston, 1938), pp. 508-509.

The policies adopted by a local board of education are only partially decided at the school district level. The decision to adopt policies is a reserved function of the local board of education under the pattern of authority delegated by higher levels of educational system organization. Thus, the local school board must decide district policy and such policy decisions become the basis of performance in the school district.

The California School Boards Association offers the following explanation of the school board's role in deciding school district policy:

The public school is an instrument of social policy. It is one of the most important instruments society has at hand to preserve its heritage and to direct its orderly evolution. Recognizing the essential value of an informed citizenry in a democracy, the State Constitution, the Legislature, and State agencies have structured the public schools to ensure the maintenance of certain basic minimum standards of education. The local school district, through its governing board, is more responsive to the social policy of the individual community, and therefore is able to adapt to the local educational needs and desires.

The concept of the purpose of the schools differ among individuals and groups because of the diversity of values in our society. These differences are expressed in the pressures brought to bear upon the board, either as individuals or as a group at official board meeting, by representatives of the community and by the press. The board must always be cognizant of the pressures that arise out of conflicting values and interests. However, the merits of all proposals must be carefully weighed so that the board's final decisions are responsive to the desires of, and in the best interests of, the majority of the community. Further, the board must exercise dynamic leadership in educating

the public to the need for improved quality in education. Only in these ways can the board formulate policy which effectively sets the goals of the schools and directs the allocation of human and material resources to best advantage.¹

Thus, the local board of education serves as the organizational control agency of society by adjusting educational performance to changing environmental requirements, evolving goals and local needs.

A general closed-loop pattern of system-environment relationships (see FIGURE 4) can be specified to exist between an educational system and its environment. This pattern of relationships can be explained in terms of the effect that policy decisions have on system inputs, product development, system outputs, product performance effectiveness and system management.

The system depends upon the environment for certain inputs; namely, resources, energy and information. Once received, these inputs must be managed and conserved in order that system performance can effectively and efficiently develop the services and products (system outputs) specified in policy decisions. The outputs of product development are delivered to the environment in fulfillment of performance requirements specified in policy decisions. The environment determines the effectiveness of system performance by judging the worth of system outputs (quality and

¹ California School Boards Association, Boardmanship: A Guide for the School Board Member (Sacramento, Calif.: The Association, 1967).

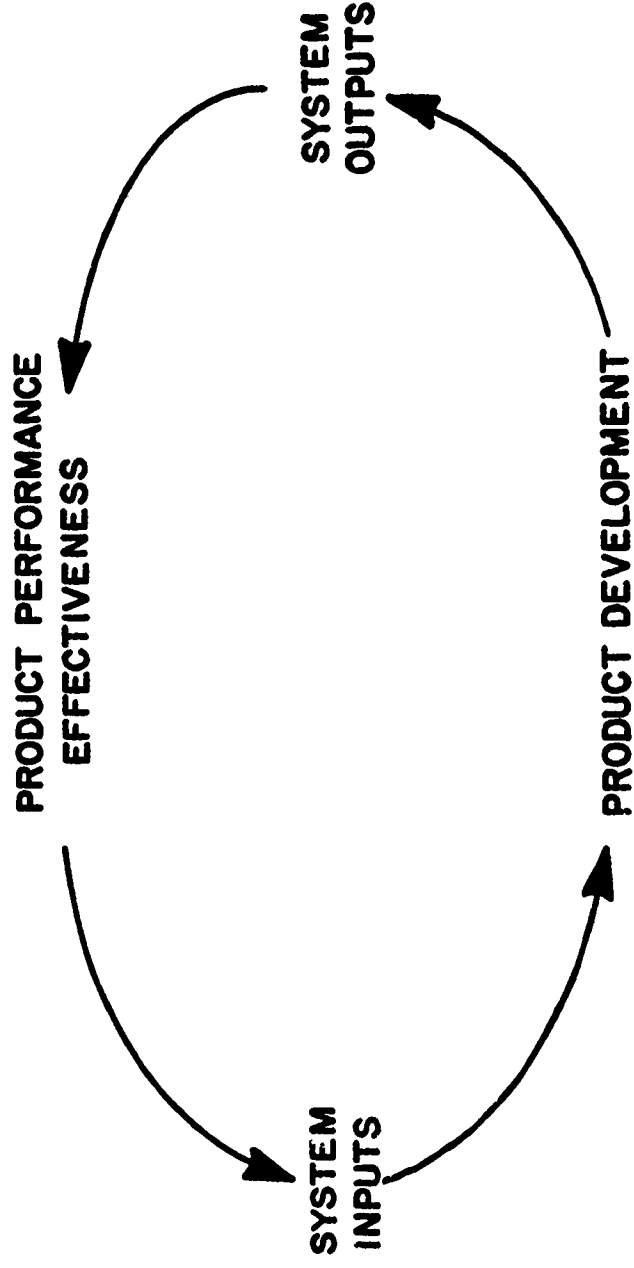
quantity) using value-based criteria or relevance.

This closed-loop pattern of system-environment relationships is, therefore, a pattern of value relationships. The culturally-based values used to determine the performance effectiveness of system outputs are also basic to the policy decisions and performance requirements which define system performance. The roles of school boards in the educational system serve to close the loop and complete the cycle. Realizing that the quality and quantity of system inputs are determined either directly or indirectly by the nature of the social benefits derived through system outputs, its not difficult to define a more detailed list of system-environment relationships.

Management

Educational management requires the exercising of policy-formulating leadership, the implementing of educational policies and the managing of educational performance. The management of performance is a quality assurance procedure designed to plan, coordinate, direct, control and organize system performance against performance requirements. Further, the management process includes the allocation of performance inputs, the establishment of a performance accountability structure and the institution of information handling procedures. The primary activities of management are problem solving and decision making. Both activities must be conducted within the scope of basic policies specified and the

Figure 4
CLOSED-LOOP PATTERN OF
SYSTEM-ENVIRONMENT RELATIONSHIPS



pattern of authority delegated by policy-making bodies in the system.

Education can, fundamentally, be regarded as a social problem which is resolved through political action. Educational management must, therefore, develop political rationality. Every educational problem can be regarded as having social, economic and political elements. There are many opinions as to which of these elements are primary, if any. Wildavsky has stressed the need to balance economic rationality with political rationality.¹ He went on to advocate the development of political rationality in decision making. He supported his position using selected quotations from Diesing as follows:

. . . the political problem is always basic and prior to the others. . . This means that any suggested course of action must be evaluated first by its effects on the political structure. A course of action which corrects economic or social deficiencies but increases political difficulties must be rejected, while an action which contributes to political improvement is desirable even if it is not entirely sound from an economic or social standpoint.²

¹Aaron Wildavsky, "The Political Economy of Efficiency: Cost-Benefit Analysis, Systems Analysis, and Program Budgeting," Public Administration Review (December, 1966), pp. 292-310.

²Ibid., p. 308.

Wildavsky stressed how Diesing had pointed out the need for developing political rationality in decision making:

Political rationality is the fundamental kind of reason, because it deals with the preservation and improvement of decision structures, and decision structures are the source of all decisions. Unless a decision structure exists, no reasoning and no decisions are possible. . . . There can be no conflict between political rationality and . . . technical, legal, social, or economic rationality, because the solution of political problems makes possible an attack on any other problem, while a serious political deficiency can prevent or undo all other problem solving. . . . Non-political decisions are reached by considering a problem in its own terms, and by evaluating proposals according to how well they solve the problem. The best available proposal should be accepted regardless of who makes it or who opposes it, and a faulty proposal should be rejected or improved no matter who makes it. Compromise is always irrational; the rational procedure is to determine which proposal is the best, and to accept it. In a political decision, on the other hand, action never is based on the merits of a proposal but always on who makes it and who opposes it. Action should be designed to avoid complete identification with any proposal and any point of view, no matter how good or how popular it might be. The best available proposal should never be accepted just because it is best; it should be deferred, objected to, discussed, until major opposition disappears. Compromise is always an irrational procedure, even when the compromise is between a good and a bad proposal.¹

Political rationality in educational decision making predicates that educational management cannot proceed independent of management in other sectors of government. Political decisions relative to education are made at the policy-making level of

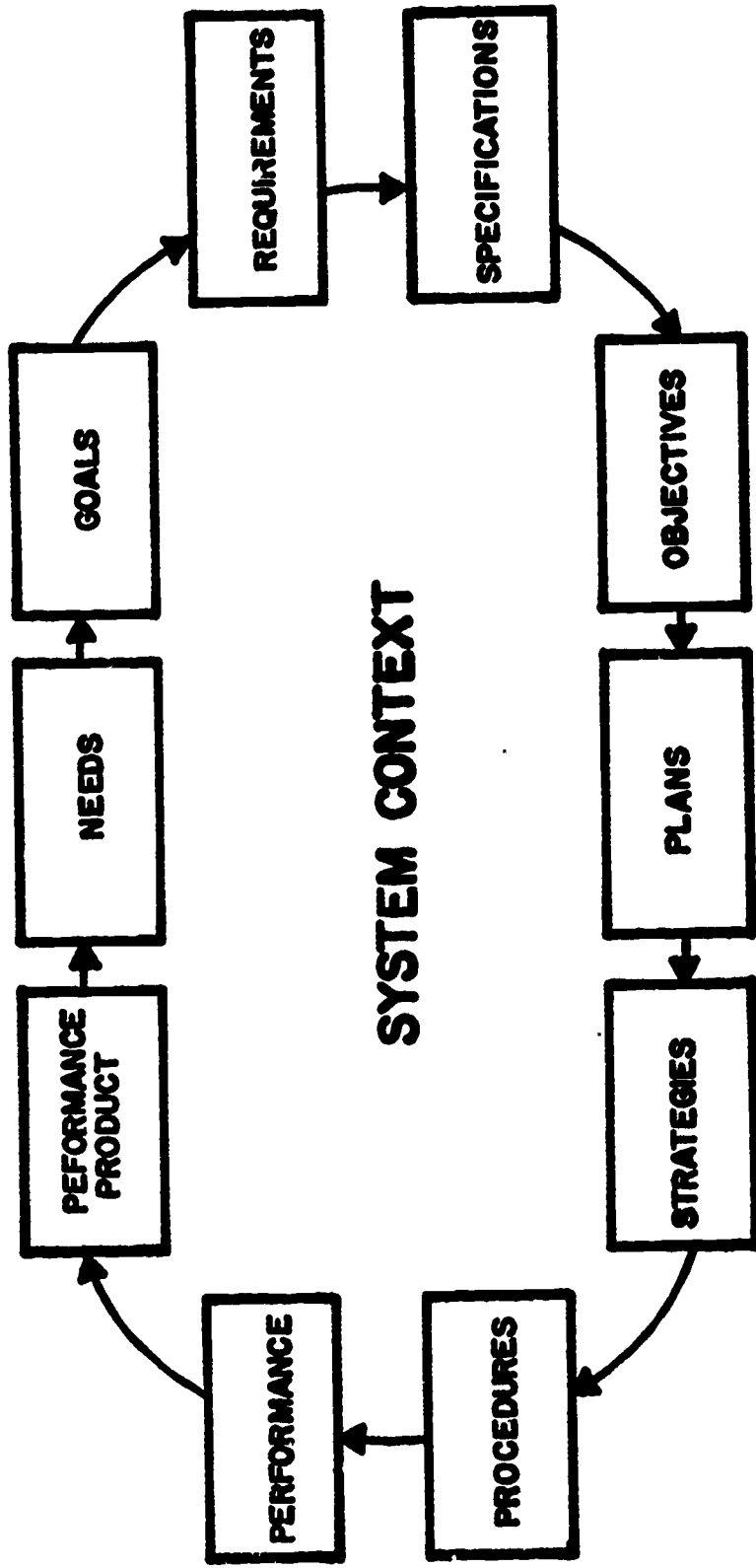
¹Ibid., p. 307.

organization and, once made, are transmitted throughout the organization structure of the educational system.

Management must secure an adequate knowledge of probable consequences before it can exercise policy-formulating leadership, make sound decisions and solve problems. The knowledge of consequences needed are: (1) a knowledge of value losses and/or deferments which society will experience if plans and programs are not carried out; (2) a knowledge of anticipated benefits (value gains) which society will experience if plans and programs are effectively implemented; (3) the costs of such plans and programs; and (4) the resulting costs-consequences ratios.

The resolution of complex culturally-based problems is a difficult process due to the nature of the problems and the patterns of human involvement required to successfully resolve them. Since an educational system has its beginning and end with people, educational decision-making and problem-solving processes are marked by negotiation and compromise. Thus, there is often little security for the professional educator participating in management. Management, therefore, continuously must strive to perfect more systematic approaches to problem solving and decision making.

A GENERIC MANAGEMENT MODEL Figure 5



ENVIRONMENTAL CONTEXT

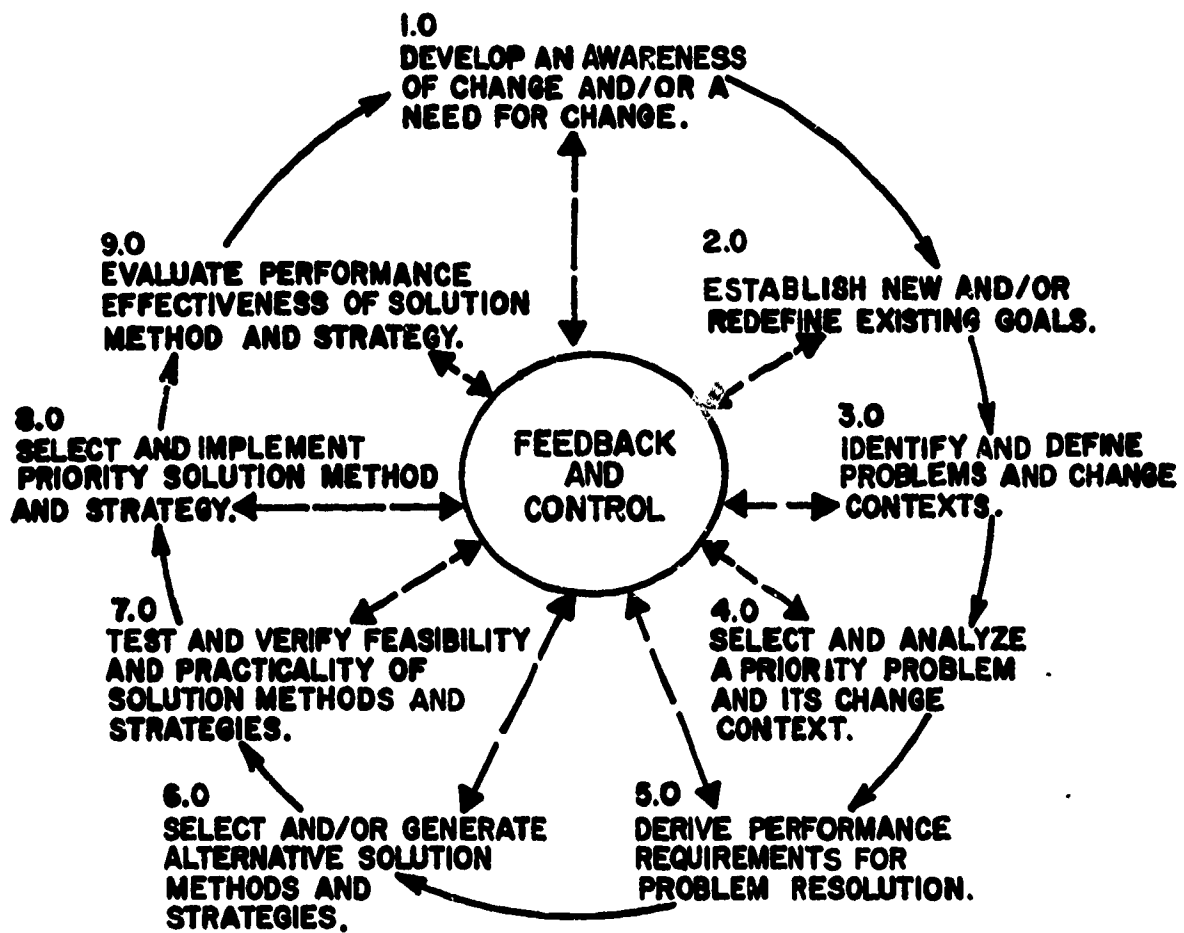
A system approach to management can be instituted to reduce some of the uncertainty accompanying problem solving and decision making. A generic management model is outlined as FIGURE 5. The following sequence of activities and events are outlined in the model:

1. The assessment and justification of needs in terms of validity criteria leads to the structuring of new and/or redefinition of existing goals.
2. The definition of goals stimulate policy formulation and the resulting policy decisions establish performance requirements which are assigned to management.
3. Management must analyze performance requirements in order that it can define a complete array of performance specifications which can be used to explain the performance requirements.
4. The specifications are classified and categorized according to levels of organization and a hierarchy of performance objectives can be defined in measurable terms.
5. Performance objectives are the fundamental basis of plans --each plan outlines a course of action and details appropriate management controls.
6. Plans must be verified in terms of the performance context and the action sequence (strategy) which has been developed to accomplish the objective.

¹It should be noted that a plan is the best alternative solution which will fully satisfy the specifications. A strategy, on the other hand, embodies the communication elements (information, education and motivation) required to make the plan work in terms of required compromises, adaptations, adjustments and concessions.

Figure 6

A MODEL OF A SYSTEM APPROACH TO PROBLEM SOLVING



7. A strategy which has been validated through feedback and control is a reliable management procedure for the achievement of objectives.
8. The establishment of a management procedure facilitates the achievement of performance consistency in spite of the internal and external constraints on performance.
9. The resulting performance can be evaluated to determine the effectiveness of performance in terms of previously specified criteria and specifications.
10. The achievement of desired levels of performance proficiency produces change. Such change will produce new needs, which, when justified, will stimulate the formulation of new goals, and the cyclic phenomenon will continue.

A model of a system approach to problem solving is presented as FIGURE 6. This model can be related to the generic management model outlines as FIGURE 5. The principal difference in the two models is that the model of a system approach to problem solving emphasizes control and feedback.

Emphasis in management must be upon control of performance in terms of requirements, specifications, objectives and criteria. Since management control must be effective within the prevailing performance context, the context must be continuously appraised. Therefore, the fundamental management control set consists of:

1. The objectives which define behavior in measurable performance terms;
2. The criteria which can be used to measure the degree of change, rate of change, type of change, direction of change, degree of commitment to change, etc., in performance;

3. The performance context description which includes the characteristics, conditions and situations indigenous to the context which are relevant to present and/or expected states of performance;
4. The performance requirements and specifications which are basic to the specified objectives and criteria.

Control is a management function that is implemented to assure that performance proceeds according to plans and directions. The control function also provides for the timely execution and revision of plans; that is, as significant deviations from plans occur, they are corrected by appropriate adjustments. Control involves management in the definition and the assignment of responsibilities according to objectives and functions. In addition, management must match assigned responsibilities with the relevant information required to execute them in the most efficient and effective manner. Thus, the essence of control is action which adjusts performance to specified standards if deviations occur.

Control procedures establish a closed-loop pattern of relationships between management and the performance units to which are assigned responsibilities for the performance of functions. Feedback is the property of this closed-loop pattern which permits the demonstrated performance (outputs) to be compared to the performance objectives and assigned functions (inputs) so that appropriate control procedures may be defined and implemented.

The principal function of feedback in management control is that it facilitates the estimation of variance occurring during performance.

The system approach to management presents both a framework and methodology which can be used to facilitate the planning, development and implementation of programs of controlled change. The principal emphasis is upon the development of procedures which can be explained in definable and measurable terms. These procedures utilize the informational benefits gained through the involvement of people in such activities as: (1) the analysis and evaluation of educational performance; (2) the analysis of the cultural environment of education; (3) the assessment of educational needs; (4) the determination of priorities for action; (5) the appraisal of relevant knowledge and technology; (6) the appraisal of relevant educational programs and their demonstrated performance; and (7) the planning development and implementation of educational programs.

This approach to management also offers several "real time" benefits to managers who adopt its methodology. The system approach has been found to allow educational management to:

1. Decrease the period of time required to formulate an accurate response.
2. Increase the number of variables which could be treated in a response.

3. Increase the rate of response.
4. Improve the quality of response.
5. Provide assurance as to the effectiveness of the response in resolving the problem.

The system approach encompasses planning, programing, budgeting and management in order that the educational system may:

1. Make the most progress in the shortest possible time.
2. Identify and assess its opportunities, risks, capabilities, capacities and requirements.
3. Maintain an effective balance between performance and changing social expectations, goals, evolving needs, roles and requirements.
4. Improve management and policy-making judgments by comparing performance to expectancies, plans, strategies and criteria of relevance.
5. Encourage educational leaders to think and act toward common purposes and to understand and appreciate the efforts and progress being made elsewhere in the system.
6. Provide a product rationale for decision making and thereby stimulate the determination of priorities, relevancies, probabilities with respect to process and service requirements.
7. Develop critical insights, functional understandings and effective communications with regard to performance in both the educational system and its environment.
8. Establish sensing and response devices which may be used to alleviate internal and/or external stresses, crises and constraints.
9. Initiate pressures for growth and development and stimulate the formulation of new roles and requirements.

10. Provide a basis for the management of performance in terms of definable and measurable requirements, specifications, criteria, objectives and plans.

Requirements

Requirements are requisite conditions (states of being) which are necessitated by the nature of things, circumstances, or the goals specified by policy-making bodies. Requirements constitute an extension of policy in that they specify: (1) the nature of the conditions which must be met or maintained through performance; and (2) the nature of the end product(s) of performance.

Two special classes of requirements are limits and constraints. Both of these classes refer to requisite conditions which must be met or maintained through performance. Limits serve in the specification of boundary conditions for performance. Thus, a limit terminates, circumscribes or confines performance. Limits may exist due to prevalent legal, financial, time, spatial, informational, material and/or energy conditions.

Constraints are forces that act during performance and may effect changes(s) in the homeokinetic properties of performance systems in four ways: (1) cause a system at rest to move toward specified goals; (2) cause a system to increase its momentum toward specified goals; (3) cause a system to decrease its goal-

directed momentum; and (4) cause a system to divert or deflect from its goal-oriented course. Thus, constraints include positive, negative and tangential forces which affect goal-directed momentum. Such forces can generally be classified into internal (system) constraints and external (environmental) constraints. Most constraints are generated by human components of the system and/or the environment.

The analysis of requirements is a key responsibility of management and administration in that the results facilitate the definition of performance specifications and criteria.

Specifications

Specifications are detailed, precise statements containing minute descriptions or enumerations of particular characteristics which define the nature of performance. Specifications result from the detailed analysis of performance requirements. Thus, performance specifications constitute an array of performance descriptors which can be made relevant to the defined aspects of performance and its context.

Specifications precisely define: (1) requirements; (2) levels of proficiency; (3) interim and terminal behaviors and/or products; (4) bases of measurement; (5) capabilities and capacities; (6) contextual characteristics; (7) prerequisites; (8) limits;

(9) internal and external constraints; (10) priorities; (11) relevancies; (12) probabilities; (13) performance relationships; (14) indicators of performance and change; (15) management activities; etc.

Specifications facilitate the management of performance and planned change. Management is based upon predictable achievement in terms of interim and terminal specifications that are defined in measurable performance terms. The terms used to define performance are limited to those rules, principles, and/or concepts which are relevant to policies and requirements. Specifications can thus be utilized to relate the aspects of future performance to present and predicted system inputs, product development (process), system outputs, product performance effectiveness, and management requirements.

The primary task of management and administration is to secure answers to the following questions:

1. What is the precise nature of the requisite conditions that must be maintained or met through performance?
2. What is the precise nature of the end products?
3. What is the precise nature of the performance and the performance states that are required for successful fulfillment of requirements?
4. What relevant relationships exist between the various aspects of performance?

The analysis of performance requirements should produce answers to

each of these questions and, in addition, yield a complete set of performance characteristics which can be defined in measurable terms.

Performance specifications must answer the primary question: "What is the exact nature of the performance requirements, indigenous to specific policies, in terms of the functional and organizational aspects of performance in the educational system?" Thus, specifications must facilitate the organization and administration of performance at all levels of structure and function responsible for performance. To facilitate performance organization, specifications must: (1) specify what must be done to fulfill requirements; (2) divide the requirements and specify segmented activities which are small enough to be completed by available performance units; and (3) specify efficient and effective management activities.

The administration of performance includes management support and the timely development, execution, control and revision of performance plans and strategies. In this regard, specifications must: (1) detail what each performance unit is to do in precise performance terms; (2) be suggestive of possible methods-means alternatives to be used in performance; (3) provide the basis for defining criteria of relevance; (4) be predictive of the performance objectives which must be achieved; (5) reflect the relevant

states and contexts of performance; (6) facilitate performance management; and (7) provide an objective basis for determining the effectiveness of performance.

Criteria

Criteria are standards on which judgments or decisions are based. They are rules, principles or tests which can be used to select alternative courses and/or methods of action. They are usually established by authority to serve as references in determining the relative worth of performance and the rightness or wrongness of performance in relation to some accepted value and/or desired value outcome of performance.

Criteria can be used as diagnostic and prognostic means for determining what the nature of performance (interim and terminal) and/or the performance products (interim and terminal) should be in relation to requirements and specifications. Thereby, they serve in the determination of the qualitative and quantitative aspects of performance and/or performance products. Criteria also facilitate the implementation of rationality into the systematic management of performance. Thus, criteria provide a means for using priorities (order and sequence determinants), relevancies (relative pertinency determinants), probabilities (consequence determinants), etc., as bases for decision-making

and problem-solving activities in management.

Since most policy decisions are choices among alternative courses and/or methods of action, and since "real world" conditions, relative to these policy decisions, are evolutionary and transitory in nature; the selection of appropriate measurement criteria is the central problem in the formulation and implementation of policy and the management of performance. Each policy decision requires corresponding decisions as to the criteria of relevance.

Drucker stressed the critical nature of the relationship which exists between a criterion of relevance and the measurement of performance. He stated that a criterion of relevance:

. . . more often than not, turns on the measurement appropriate to the matter under discussion and to the decision to be reached. Whenever one analyzes the way a truly effective, a truly right, decision has been reached one finds that a great deal of work and thought went into finding the appropriate measurement. . . .

The effective decision-maker assumes that the traditional measurement is not the right measurement. Otherwise, there would generally be no need for a decision; a simple adjustment would do. The traditional measurement reflects yesterday's decision. That there is a need for a new one normally indicates that the measurement is no longer relevant. . . .¹

Thus, Drucker implies that pertinent data cannot be gained unless there are first criteria of relevance.

¹Peter F. Drucker, The Effective Executive (New York: Harper and Row Publishers, 1966), pp. 144-145.

Criteria may be relative or absolute. Relative criteria may be used to measure the achievements of a performance unit in terms of the levels of achievement demonstrated by a group of corresponding units performing the same or related functions and/or tasks. Relative criteria can be structured in terms of efficiency, proficiency, effectiveness, costs, benefits, advances, etc. One of the most serious limitations of relative criteria in performance management resides in their orientation to past and present periods of time.

Absolute criteria are structured to measure performance and/or achievement using arbitrary, pre-specified standards of relevance. Absolute criteria facilitate the management of performance in that they can be used to measure minimum levels of acceptable performance in terms of previously defined requirements, specifications and objectives which reflect the priorities, relevancies, probabilities, etc., of the organization with respect to future time.

Management must carefully structure criteria in order that it can gain valid evidence of strengths and weaknesses in performance. Such criteria enable performance to be:

1. Replicated--others can use the same procedures to achieve similar results.
2. Made explicit--all aspects of performance and results are clearly visible.
3. More specific--performance has been carried to satisfactory levels of specificity and has achieved acceptable

levels of reliability and proficiency.

4. Verified--procedures and results can be confirmed or substantiated.
5. Self-correcting--procedures provide for continuous revision through control, feedback and iteration.
6. Logical--procedures and results are in accordance with inferences reasonably drawn from events, conditions, situations and/or circumstances.
7. Objective--uncertainty and subjectivity have been reduced to the minimum levels possible.
8. Quantifiable--numbers and number relations can be applied to procedures and results.
9. Empirical--procedures and results can be verified through experience, experimentation, observation, etc.
10. Effective--procedures produce results that are decisive.

Finally, criteria must be reasonable yet consistent with policies, requirements, specifications and objectives. They must be made sensitive to the priorities, relevancies, probabilities, etc., which are indigenous to performance plans, strategies and procedures. Thus, criteria are tools which extend human capabilities in the management of performance by serving as bases for judgment and decision.

Objectives

The importance of objectives resides in the fact that they define the purpose of organization and without purpose there would be no reason why individuals should try to cooperate or why anyone

should try to organize them. Every organization and each of its parts must be an expression of the purposes of that organization. At every level of performance in an organization, objectives serve as communication referents and as guides to achievement through performance.

The specification of objectives depends upon information derived from policy decisions, requirements and specifications. Objectives are management tools and thus an integrated, time-phased hierarchy of objectives which are ordered in terms of priority programs and which are sequentially allocated to finite periods of time constitute a master plan for management action.

Objectives should be defined in measurable performance terms. Each objective should be feasible of attainment within the prevailing performance context. In addition, objectives should be stated completely, yet concisely and simply, in order to achieve clarity in communication effectiveness. Further, each objective should be rational in terms of organizational purposes and should be oriented to the nature of the performance desired as outputs. Finally, each objective should be written as a separate statement and a set of relevant objectives should be disseminated to each performance unit in the organization.

It must be remembered, however, that objectives are tentative in nature and must, therefore, be continuously appraised in terms of changing goals, roles and requirements. Management must, therefore, perform environmental analyses and need assessments to check the validity of its current objectives. Such actions will enable management to identify changing goals and trends in society and determine the extent of changes required in the hierarchy of objectives specified for the organization.

Testing the validity of an organization's objectives is a continuous task of management. In this regard, Granger presented several key insights:

How can validity of an objective be tested? What should an objective accomplish? Here are some important criteria to be applied to an objective:

1. Is it, generally speaking, a guide to action? Does it facilitate decision making by helping management select the most desirable alternative courses of action?
2. Is it explicit enough to suggest certain types of action? . . .
3. Is it suggestive of tools to measure and control effectiveness? . . .
4. Is it ambitious enough to be challenging? . . .
5. Does it suggest cognizance of external and internal constraints? . . .

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6. Can it be related to both the broader and the more specific objectives at higher and lower levels in the organization? . . .¹

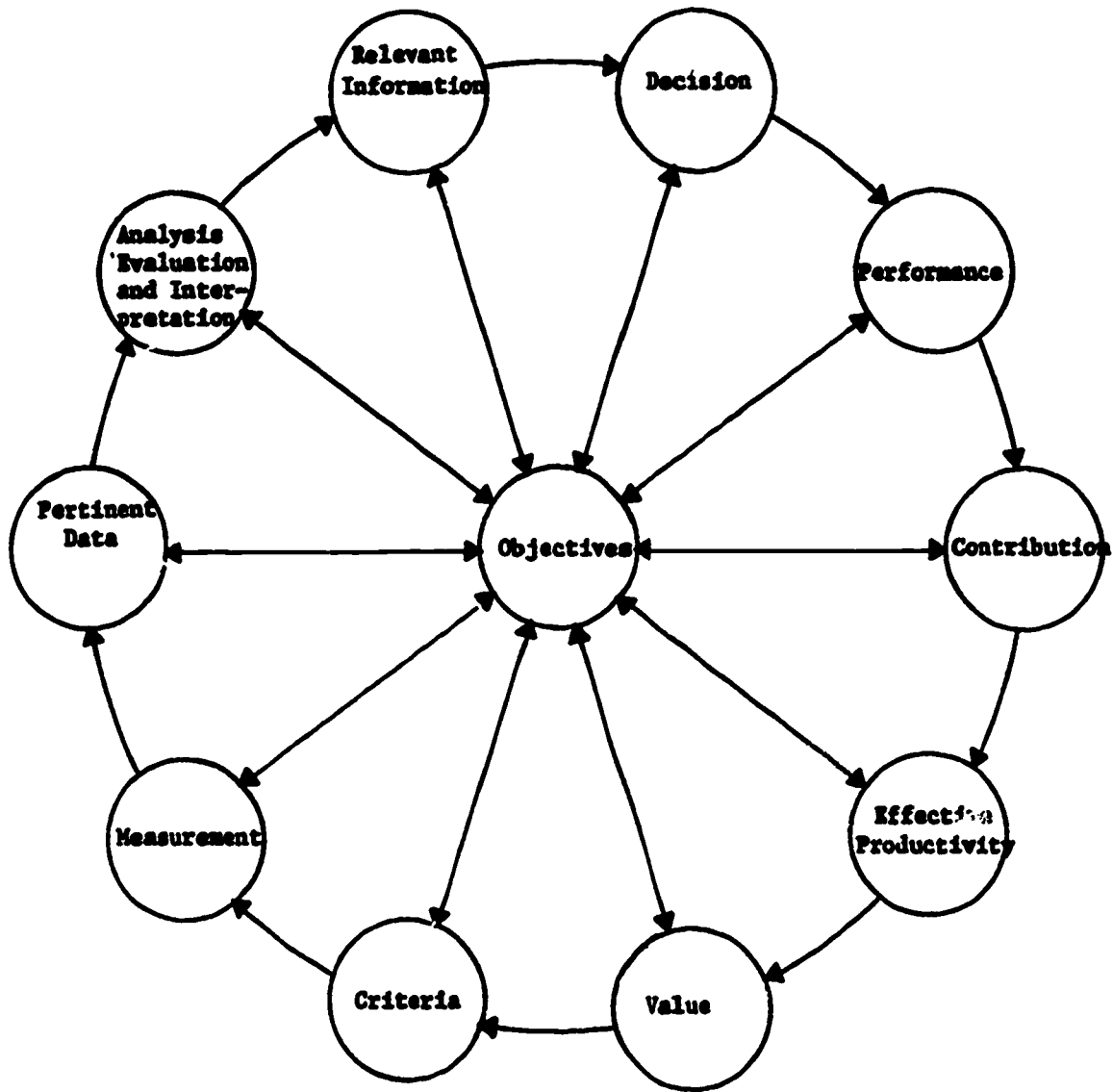
One of the principal features of a system approach to management is that it facilitates management by objectives. Objectives are thus the central elements in a cycle of management decision relationships (see FIGURE 7). The following relationships can be specified to exist in the cycle:

1. The evaluation of demonstrated performance in terms of objectives yields an indication of the significance of the contribution that has been made.
2. The contribution of a performance unit, when related to objectives, provides an indication of its effective productivity.
3. The effective productivity of a performance unit in relation to objectives enables the determination of the worth of performance and the assignment of value to performance outputs.
4. The values assigned to performance and/or performance products, when related to objectives, provides a basis for the specification of criteria.
5. Criteria of relevance, when related to objectives, provide a basis for performance measurement.
6. The measurement of performance in relation to objectives yields pertinent data.
7. Pertinent data, when related to objectives, facilitates

¹Charles H. Granger, "The Hierarchy of Objectives," Harvard Business Review, (May/June, 1964), 42(3): 63-74.

2

THE CENTRALITY OF OBJECTIVES IN A CYCLE OF DECISION RELATIONSHIPS **FIGURE 7**



the analysis, evaluation and interpretation of data pertinent to performance.

8. The analysis, evaluation and interpretation of pertinent data in relation to objectives yields relevant information.
9. Relevant information, when related to objectives, provides a basis for decisions.
10. Decisions made with respect to objectives lead to performance.

The foregoing relationships emphasize the importance of specifying objectives in definable and measurable terms. The cycle of relationships outlined is primarily oriented to future time and future opportunities. Since management needs feedback in advance of decisions, complementary use of the cycle may be made for the purpose of securing knowledge relative to probable consequences. Another cycle of feedback relationships could be structured using a reverse form of the cycle. The purpose of the second feedback cycle would be to: (1) derive performance feedback; (2) facilitate iteration and revision; and (3) provide management control. Used in this manner, the cycle would be primarily oriented to present performance.

Administration

Administration requires the exercising of management support leadership, the planning, developing and implementing of management procedures and the controlling of educational performance.

An administrator is a member of the management team and is required to perform all of the functions assigned to management. Thus, administrators are generally delegated authority and assigned responsibility to transform policy and management decisions into operational procedures which can be managed.

Administration can generally be regarded as the operational arm of management and, as such, is responsible for the service image of management. It is responsible for research, planning, development, implementation, information, and liaison services. Since management is oriented to present and future requirements and conditions, the designing of programs of planned change is a primary function of administration.

Planned change in education requires that concentrated effort be devoted to planning, programing, budgeting and management procedures relative to change. The principal emphasis in planning is upon the production of a range of meaningful alternatives which satisfy specific policy and management decisions. Each of the alternatives must be carefully designed to meet relevant performance specifications and criteria. In addition, the alternatives produced represent preliminary change proposals which can be related to current and/or proposed programs and objectives.

A program may be defined as a set of related events, activities

and organizational components and its definition must be specified in terms of organizational objectives. Programing is the more specific determination of the human, physical and financial resources required to complete a program. Further, programing includes assessment of the energy requirements for program completion. In addition, programing is based upon relevant information which must be secured before performance can be initiated. Thus, programing involves the estimation of performance requirements, specifications, criteria, capacities and capabilities.

The results of planning and programing must assure the quality of performance in terms of both efficiency and effectiveness. Both efficiency and effectiveness require lead information with respect to performance. Therefore, management must secure an adequate knowledge of the correspondence between policy alternatives (choices) and probable outcomes (consequences). This knowledge can be related to system inputs, product development, system outputs, product performance effectiveness and system management procedures.

Central to such studies are the three knowledge states which have been specified to exist in choice-consequence relations:

- (a) Certainty: It is assumed that there is complete and accurate knowledge of the consequence of each choice.

(b) Uncertainty: The consequences of each choice cannot be defined by a correspondence relationship even within a probabilistic framework.

(c) Risk: It is assumed that accurate knowledge about the probability distribution of the consequence on each alternative exists.

Certainty implies a state of awareness on the part of decision makers that seldom exists. The emphasis on certainty or deterministic foundations in decision making is a holdover from the early association of social and physical sciences. Some contended that the laws of the physical sciences and the related deterministic quantitative methodology might be extended to social behavior. But the contemporary revolution in both social and physical sciences has done much to minimize this view.

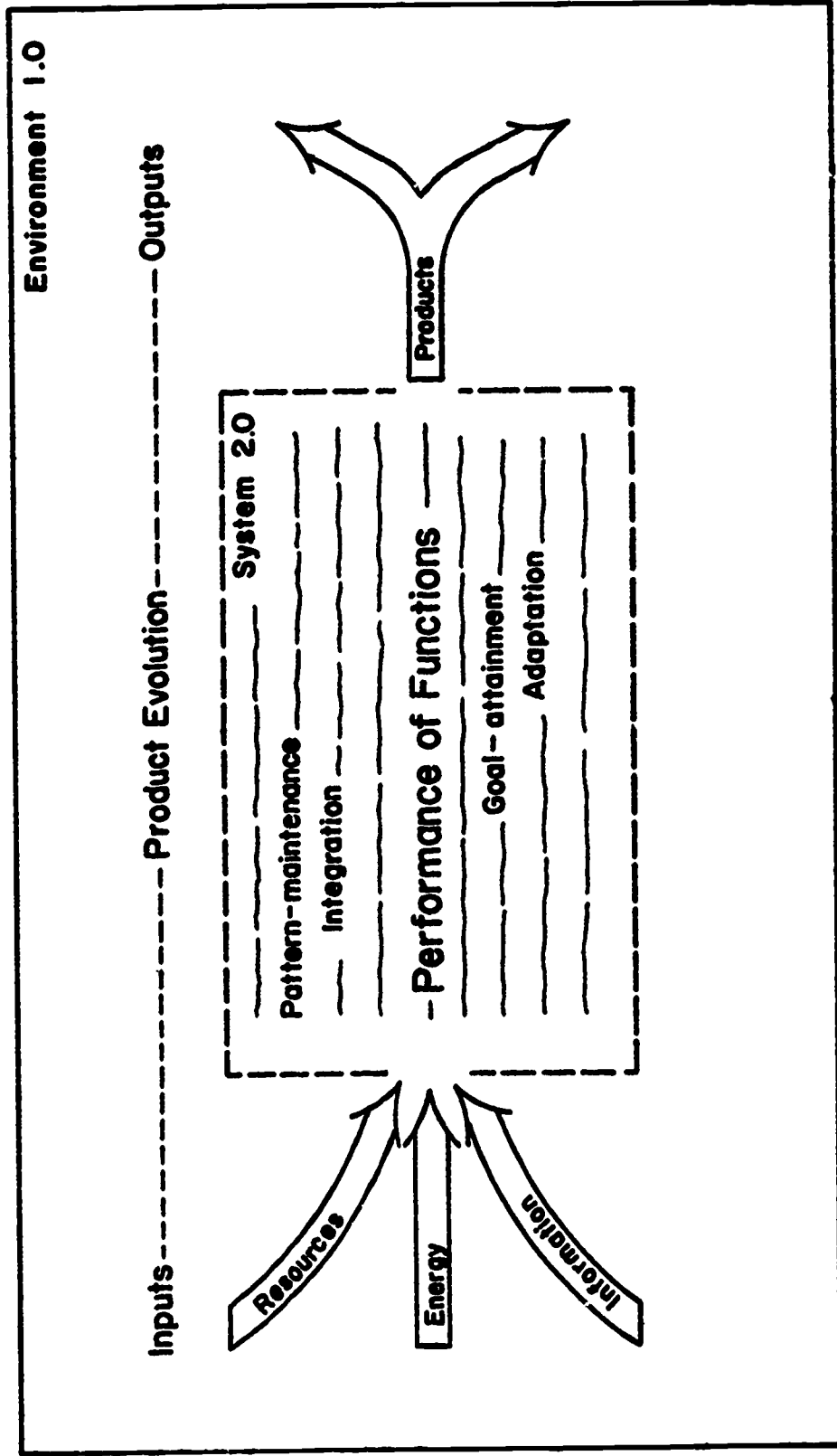
Genuine uncertainty is untenable in "closed" decision models. A basic premise in all "closed" decision models is that alternatives and consequences as well as goals are given. Thus, at least equal probabilistic measures can be assigned to possible outcomes of a given course of action. The current developments in subjective probability have done much to eliminate states of genuine uncertainty.

It is fair to say that models of risk dominate the kinds of foundations assumed in decision theory. The likelihood of each of the possible outcomes resulting from a particular course of action can generally be stated in either an objective or subjective probabilistic frame of reference. This is true if all outcomes for a given course of action cannot be specified independently.¹

Closely allied with these sets of knowledge concerning choices-consequences relations is the need for establishing an effective communication network and instituting efficient management information handling procedures.

¹Charles Wilson and Marcus Alexis, "Basis Frameworks for Decisions," in William F. Gore and J. W. Dyson (eds.), The Making of Decisions (New York: The Free Press of Glencoe, 1964), p. 184.

A Model of System - Environment Relationships Figure 8



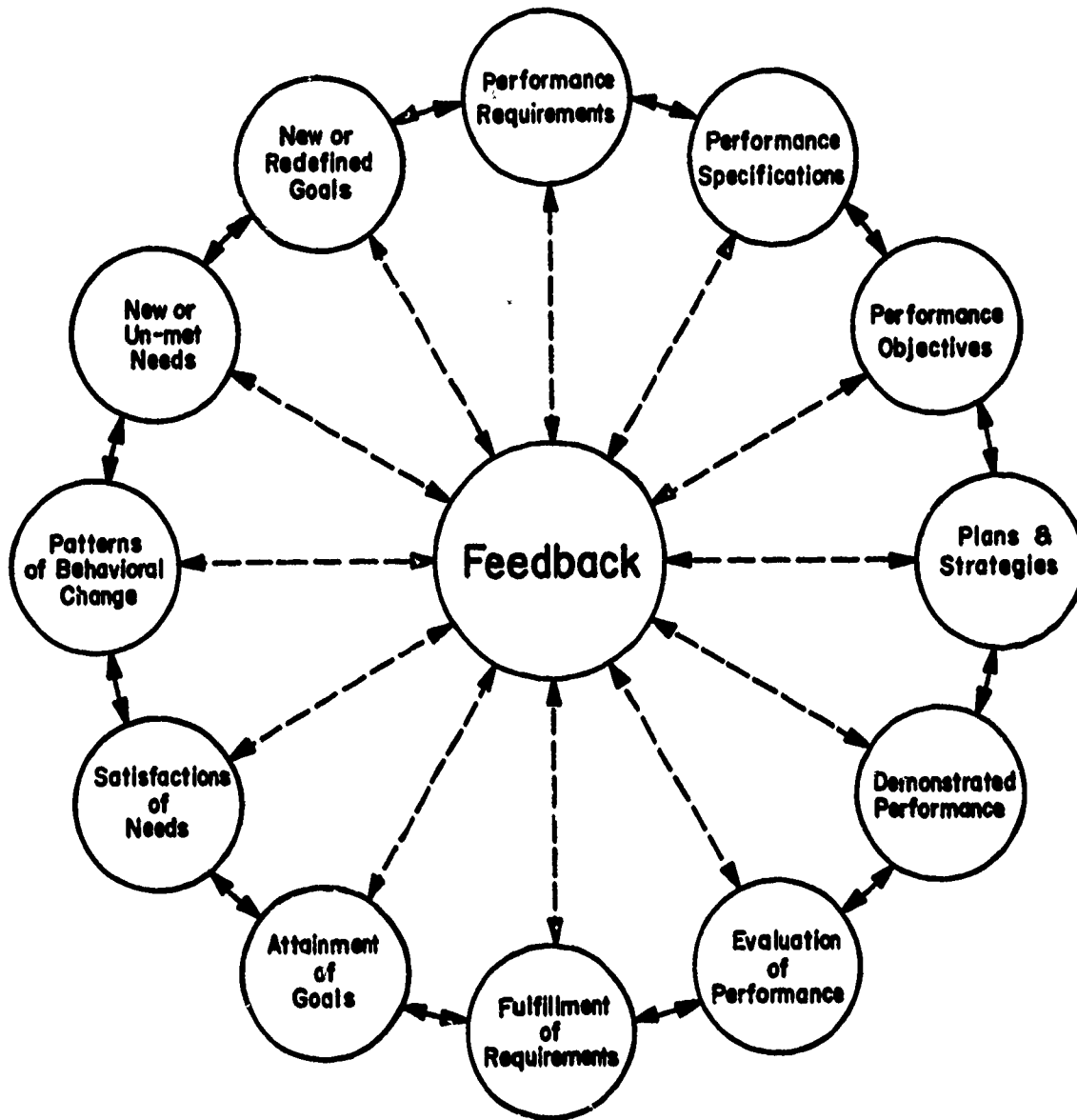
The establishment of a communication network must be based upon a functional design which considers the essential communication elements; namely, information, instruction and motivation. The purpose of such a communication network is to facilitate the achievement of the following functional imperatives in performance (see FIGURE 8): (1) the achievement of specified objectives (goal-attainment); (2) the maintenance of the dominant pattern of values prevalent in the cultural context (pattern-maintenance); (3) the integration of the functional and organizational aspects of performance (integration) to achieve educational purposes through the establishment and maintenance of a flexible performance capability which can be adapted (adaptation) to meet changing roles, requirements and future needs.¹

FIGURE 9 reveals the centrality of feedback in a communication network which is established to analyze performance. Feedback information provides a test for the validity and effectiveness of problem-solving decisions against the actual course of events which take place. Control and feedback are thus combined in management control procedures which are designed to assure that plans will succeed. Thus, management control procedures:

¹Adapted from Talcott Parsons, as presented in Society: Evolutionary and Comparative Perspectives (New Jersey: Prentice-Hall Publishers, 1966), pp. 5-29.

Analysis of Performance Cycle

Figure 9



**Centrality of Feedback
in the Communication Network**

(1) define measurable standards by which performance can be assessed; (2) provide a framework and methodology for the assessment of performance; and (3) establish procedures for the correction of performance deviations.

Management information handling is required at each level of organization in the educational system. The primary functions in handling information include the selection, acquisition, storage, retrieval, analysis, evaluation, validation, synthesis and utilization of information. Since each of these functions may be associated with every aspect of performance, management procedures in this area are critically important.

Budgeting is the planning and development of a functional plan for the coordination of performance inputs (resources, energy and information) and expenditures; in terms of performance requirements and the pattern of authority delegated by policy-making structures of the system. The budgeting process includes the development of a statement of the financial position of the system for a definite period of time, or for definite periods of time, based on estimates of revenues and expenditures anticipated during the budget period, or periods, and the proposed alternatives for securing revenues and allocating inputs. Thus, a budget is a formal expression of policy and budgeting which entails the exercising of policy-formulating leadership.

The management procedures in administration can be related to personnel, operational, management support and instructional services. Personnel services involve administration in staffing activities relative to both classified and certificated personnel. Operational services involve administration in accounting, legal, operational and maintenance services. Management support services have already been discussed. Finally, instructional services include pupil personnel and curricular services.

Plans and Strategies

The development of plans and strategies for the achievement of organizational objectives is based upon a comprehensive analysis of the planning information available to the educational system. This analysis would include:

1. Testing the validity of the objective and making necessary refinements in its definition.
2. Analyzing the implied mission of the objective and developing a sequence of milestone events and primary functions (mission profile) to accomplish it.
3. Analyzing the mission profile to determine the lower level functions which must be performed in order to accomplish the mission.
4. Analyzing each of the identified functions to determine the related tasks which must be performed to complete each function.
5. Analyzing the available method-means alternatives which can be implemented to complete the identified tasks and functions.

6. Developing performance strategies and selecting that alternative strategy which presents the most effective and rational method for achieving the objective.
7. Developing management and evaluation procedures which assure specified levels of quality in performance and determine the effectiveness of the strategy selected.

Johnson, Kast and Rosenzweig stress the importance of effective information flow in planning.¹ In addition, the same authors stress the relationship between objectives and plans as follows:

Of prime importance in the establishment of a hierarchy of plans is the setting forth and acceptance of organizational objectives. Clear-cut, well-defined organizational goals and objectives help provide the basis for systematic planning at lower operating levels. Some of the benefits of goals as guides for further planning are that they provide:

1. The basis for unified and integrated planning.
2. The premises within which more specific planning should take place.
3. The primary basis for the performance of the control function.
4. A primary basis for human motivation--a sense of accomplishment in terms of known goals and objectives.
5. A basis for well-defined delegatin and decentralization of specific planning to lower operating levels.
6. A basis for coordinating the activities between various, often diverse functional operating units within the organization.²

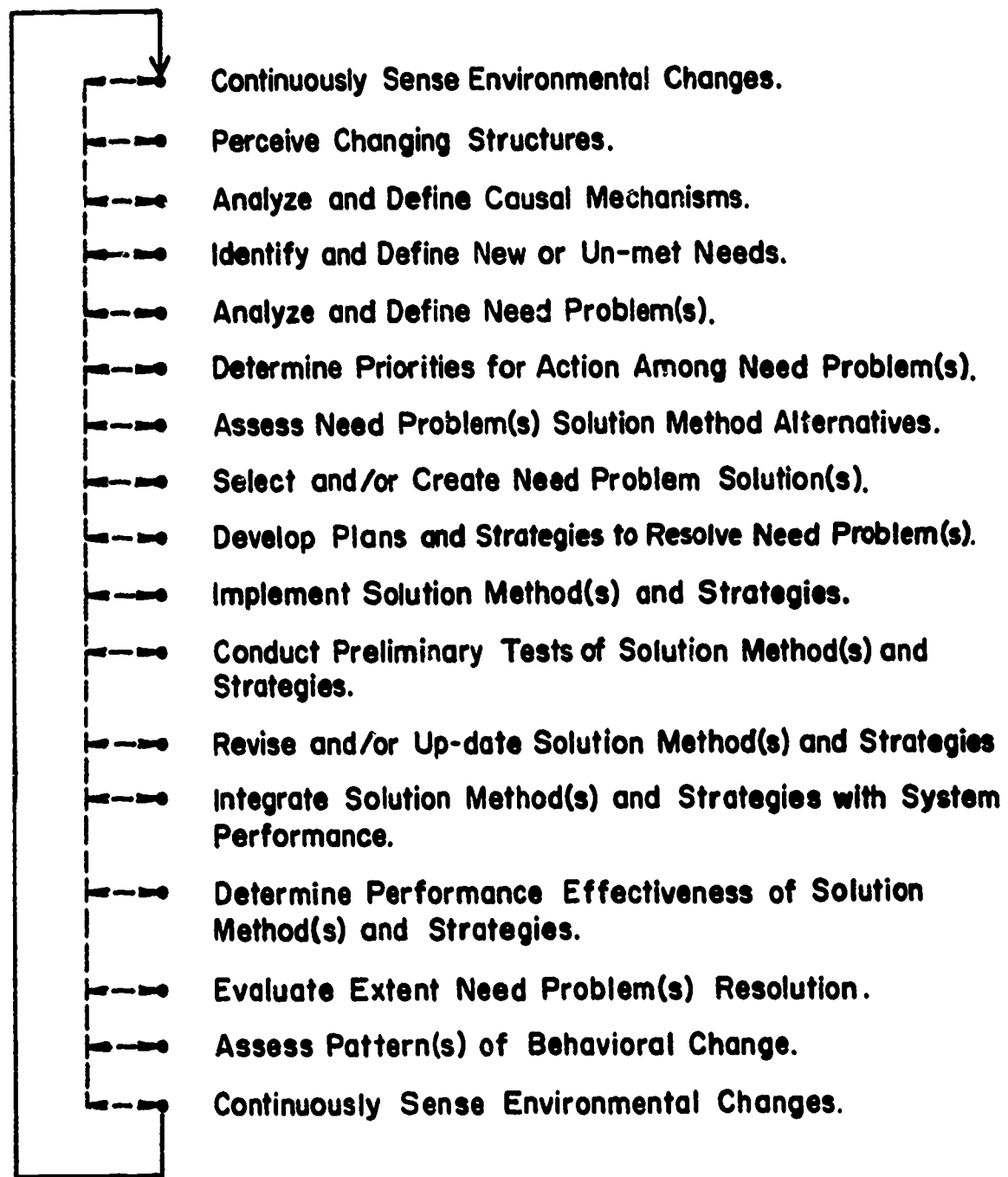
Generally, performance units at the management and administrative levels develop management procedures which outline a

¹Richard A. Johnson, Fremont E. Kast and James E. Rosenzweig, The Theory and Management of Systems (New York: McGraw-Hill Book Co., 1967), pp. 28-31.

²Ibid., p. 30.

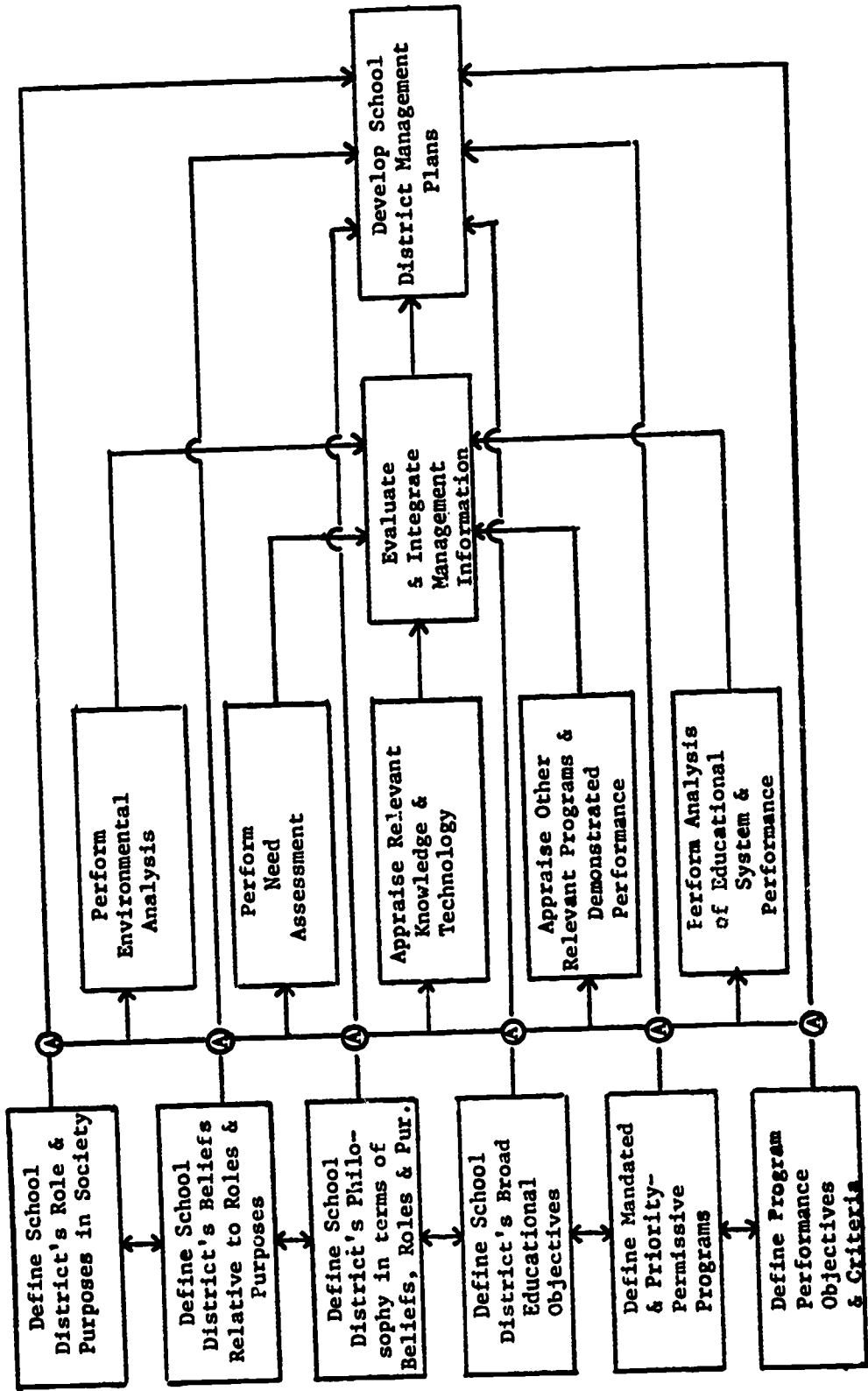
A PLANNING STRATEGY

Figure 10



MODEL OF GENERIC FUNCTIONAL RELATIONSHIPS
IN THE DEVELOPMENT OF SCHOOL DISTRICT
MANAGEMENT PLANS

Figure 11



sequence of operations to be followed in developing plans and strategies. FIGURE 10 presents a sequence of suggested planning functions that can be arranged as a closed-loop. This strategy reveals planning, development and implementation activities along a continuum. Thus, the strategy outlined can serve as a generic procedure which can be adapted for use in many problem areas.

A model of generic functional relationships in the development of school district management plans is detailed in FIGURE 11. The model outlines a framework and indicates a methodology which can be used to develop school district management plans that will be consistent with the policy-formulation leadership and policy-implementation requirements of management. Management plans developed using this framework and methodology would be oriented to the defined objectives and criteria for performance in the organization.

A master plan for management action is an integrated, time-phased hierarchy of objectives which has been ordered in terms of mandated and priority-permissive programs and which has been sequentially allocated to a definite period, or definite periods of time. The master plan is structured using the functional relationships delineated in the left-hand column of the

model presented as FIGURE 11. The master plan may exhibit short-range, intermediate-range and long-range planning components. It serves as the first generation plan from which second, third, fourth, etc., generation plans and corresponding strategies are developed.

The master plan also serves as the design basis for management information-feedback (I-F) linkages in the communication network. Such I-F linkages provide information relative to both the educational system and its environment. They also facilitate the collection of feedback prior to commitment decisions which will determine future performance.

In addition, the master plan serves as the comparative baseline for the appraisal of alternative courses of action. It provides management with a basis for the prediction and analysis of the probable consequences to be experienced if a given decision alternative is selected. Thus, the master plan is a management tool which serves as the primary referent for management decisions.

Operations

Operations are sequences of procedures which have been defined in relation to specific objectives, programs and/or services. At the operational level of organization in an educational system, the programs and services of the organization interface with the

environmental clients (students and adults) who receive the benefits of such services. All programs and/or services must be defined in terms of client benefits which can be made relative to organizational objectives.

Operation requires the exercising of management and administrative support, the implementation and operation of management procedures, the analysis and control of performance and the resolving of performance-related problems. Thus, operation constitutes an extension of management to all functional and organizational levels of the educational system. The operations level of organization is the level at which service action is performed in the educational system.

At the operations level of organization, the decisions of policy-making bodies, management and administration are implemented. Most operations involve the interaction of process and product; that is, the service client interacts with the process elements designated in organizational plans, strategies and procedures. In this regard, operations constitute the functional arm of management and administration. The service and/or program responsibilities assigned to administration are performed through operations.

In most educational systems, the key to successful performance at the operations level of organization resides with teachers. And

through teachers and other staff members, the functional and organizational aspects of system performance are made available to the learner. Many varied and diverse management and administrative procedures have been developed and implemented to facilitate instruction. Each of these innovations require management and administrative facilitation at the operational level for success.

Units of work (tasks and functions) indigenous to specific programs are assigned to specialized performance units at the operations level of organization. The successful completion of all programs requires cooperative action by performance units located at all levels of organization. Such action is coordinated by management and administration through the use of clearly specified objectives which serve as guides to achievement. Performance achievement must be secured within the prevailing performance context and the worth of such achievements must be established through evaluation using criteria of relevance.

Evaluation

Insight into the purpose of evaluation has been provided by Sorenson of the Center for the Study of Evaluation of Instructional Programs. He presented the following set of assumptions with respect to evaluation:

1. Educational institutions should serve the needs of society and of the individuals who comprise it; these needs are complementary and interdependent.
2. A society's needs can best be defined by the members of that society through discussion, persuasion, and, ultimately, through voting. To insure that the goals of education will correspond with the citizens' views of their needs, the goals should be defined in a process of interaction between professionals and representatives of the society.
3. Every society changes; its needs and values are in a constant state of flux. . . . Concomitantly as our needs and values change, we must expect our educational goals to change.
4. Even though many of our values seem to be changing, we continue to prize diversity. Ours is a pluralistic society with different religions, political viewpoints, subcultures, and values. . . . To accommodate such a diverse population, we must expect our educational goals and practices to be varied.
5. The goals of our educational institutions are not and never have been limited to purely academic objectives. Most people want the schools to do more than to teach the traditional academic subjects: they want individual and societal objectives included.
6. We can tell if an educational program or teaching method is working only by observing whether hoped-for changes are occurring in the students--while at the same time making certain that damaging changes are not occurring . . . We cannot properly evaluate an instructor or a program without assessing the effects, wanted and unwanted, on students. To evaluate a schedule of events within a school, or a series of teacher activities, or any array of teacher characteristics while neglecting the product is to examine intentions without considering consequences.
7. Educational goals must be stated in descriptive rather than in interpretive language. . . . we must develop objectives defined in terms of changes in pupils' behavior or in the products of student behaviors. . . . We must be prepared to defend each behavioral goal in terms of value assumptions and to answer the question

why one particular behavioral goal is better than another. . . . the proper way to evaluate both the educational process and the structure of the schools is to find out whether they are in fact producing the hoped-for product.¹

Evaluation is defined as the process of determining or judging the value of performance and/or assigning values to performance outputs. Evaluative processes must be continuously carried out by performance units at all levels of function and organization in the educational system. The primary referents in evaluation are specifications and criteria. The secondary referents in evaluation include: objectives, plans, strategies and procedures used as management guides to achievement through performance. Another set of secondary referents include the performance context description and system's capability to perform. The principal outcome of the evaluation process is reliable information relative to performance and its effectiveness.

Context

A context is a definable and measurable unit of performance and organization consisting of a set of related and interacting factors and events which are perceived to exist within the boundaries

¹Garth Sorenson, "A New Role in Education: The Evaluator," Evaluation Comment (January, 1968), Vol. 1, No. 1.

and dimensions of the unit. Contexts can be defined relative to performance requirements, problems and planned change. Thus, a context is a designated portion of a system which encompasses the particular set of variables and/or phenomenon to be investigated.¹ Any context can be explained in terms of situations, conditions and characteristics.

Contextual situations are the domains of circumstance in which the context is located. Such domains of circumstance include external, internal and interface relationships and interactions. Thus, contextual situations include those domains of circumstance which serve to explain the dynamic aspects of the context in relation to the dynamic aspects of its surroundings, or environment.

Contextual conditions are defined as the states or modes in which the context exists or which gave rise to the context. Such conditions are used to define the precise nature of the existing context and the situational antecedents which served to influence the nature of its present existence. The definition of conditions is performed using a functional approach to context analysis and explanation.

¹This definition avoids the use of such terms as subsystems, system components, management systems, instructional systems, etc. This is not to imply that the author discredits such usage but rather that the alternative used facilitates the development of a comprehensive focus upon an educational system as a rational whole.

The characteristics of a context are the descriptive, qualifiable, and quantifiable features of a context which can be used to describe its precise nature. Thus, characteristics are descriptors of the context which facilitate both its definition and its measurement.

The application of the tools and techniques of logical analysis to a given context will produce the relevant information required to understand the dynamics of the context and explain the characteristic actions, patterns and structures occurring in it during performance. When logical analysis procedures have been used to investigate complex problems which can be defined within a designated context, man has been able to derive the relevant information required to understand the functional and organizational aspects of the problem and its context. In addition, this understanding has facilitated the synthesis of alternative solution methods for resolution of the problem.

Performance Units

Performance units are the units of structure and function in any organization. Performance units can be defined at all levels of function and organization in the educational system. Such units may consist of one man, one machine, aggregates of men, aggregates of machines and/or aggregates of men and machines. The determinant

in performance unit definition resides in the specification of units of work (tasks and functions) which must be performed to achieve previously specified objectives.

In an educational system, most units of work can be defined in terms of the system's basic educational purposes. Definition of units of work in terms of educational objectives enables the specification of job descriptions in the same terms. In addition, the job can be specified in terms of the key relationships it requires with other jobs, the purpose of the job with respect to organizational requirements, the scope of the job in the organization and the tasks and functions indigenous to the job. Job descriptions for each performance unit can be defined and specified in terms of objectives.

Thus, performance units may be made up of such human components as students, instructors, administrators, managers, policy makers, counselors, consultants, parents, etc. Machine components in performance units might include calculators, computers, data processing equipment, television equipment, projectors, recorders, duplicators, typewriters, office machines, etc. The configuration of components (structure) required in a performance unit is determined by the nature of its functional requirements specified in the job description.

The performance demonstrated by each performance unit must make a valid contribution to the achievement of organizational objectives. Each unit must be continuously justified in terms of its effective productivity. Thus, the performance of each unit must be continuously managed, analyzed and evaluated in terms of its contribution to organizational effectiveness.

Capability

The performance capability of an educational system can be defined in terms of its capacity to perform, the nature of its performance opportunities, the nature of the context in which performance is to take place and the manner in which performance is managed in the system. System capability may be real or potential. Real in those instances when the capability is efficiently achieving effectiveness and potential when the total capacity of the system is not being used. Capability is always subject to degradation through inefficiency resulting from poor management.

The capacity of an educational system to perform depends upon the nature of performance and/or performance product requirements and system inputs in relation to existing capacity. Management effectiveness has a direct effect upon capacity; especially when available energy is managed and conserved with due regard for

entropy, catalysis and synergy.

The nature of the performance opportunities has a direct effect upon system capability. One opportunity may lend itself well to the existing capability of the system while another opportunity may prove to be completely unsuited to the same capability. The psychological factors which influence opportunity-capability decisions cannot be overlooked. In addition, the sociological and psychological aspects of leadership affect the quality of opportunity-capability decisions.

The particular characteristics, situations and conditions indigenous to the performance context bear a direct influence upon performance capability. The time and spatial dimensions of the context can serve to concentrate or diffuse the performance capability. In addition, complex situational antecedents and/or involved conditions will also directly affect the quality of the performance capability.

Finally, the quality of the management procedures utilized in educational performance has a direct effect upon capability. Effective management performance serves to minimize the negative effects of other influences active in determining capability and facilitates the achievement of maximum levels of performance capability and effectiveness. Thus, management efficiency and

effectiveness is the critical determinant of educational system capability.

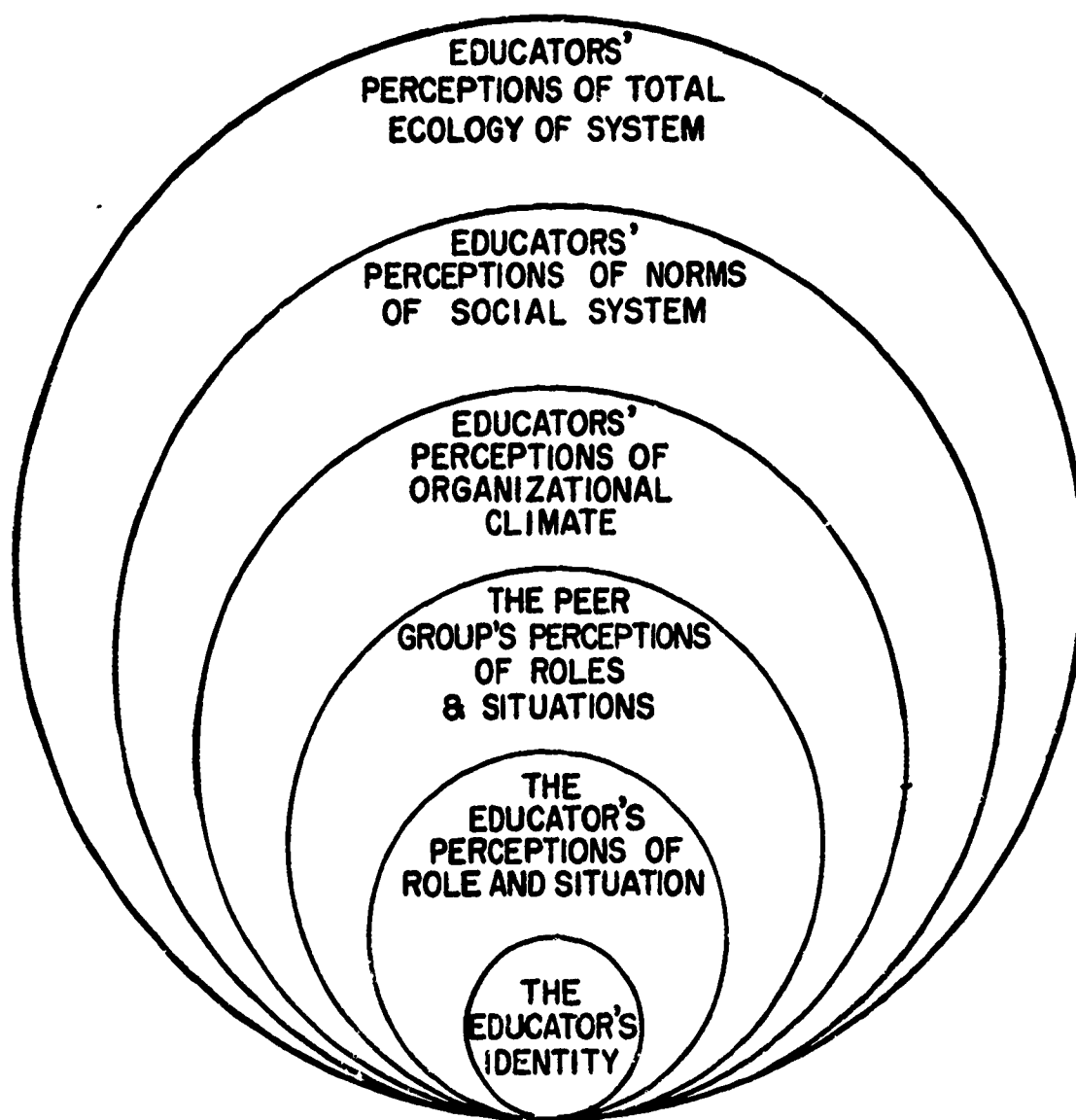
Performance

Performance is the act of achieving organizational objectives and the fulfilling of requirements. Performance cannot be completed independent of human judgments and concerns. At every key position in the environment as well as the educational system, the interaction of human beings largely determines the course of action demonstrated as performance. As is indicated in FIGURE 12, the values, aspirations, motives, needs, expectations, and, therefore, the perceptions of individuals are conditioned by the attachments each individual is able to effect in the cultural context. Thus, the pattern of human concerns and the priority relationships which exist among these concerns are predicated by situational antecedents which may be remotely or immediately related to these concerns and the individual's present perception of them.

Each area of concern in performance can be presented in terms of organizational and functional relationships. These areas of concern can be analyzed as each relates to the organizational objectives to be achieved, plans and strategies to be implemented, functions to be performed, problems to be solved, decisions to be made, and the values to be served during performance.

DOMAINS OF BEHAVIORAL INFLUENCE IN SCHOOL ORGANIZATION Figure 12

THE BEHAVIOR OF EDUCATORS IS INFLUENCED BY INDIVIDUALS' PERCEPTIONS OF IDENTITIES, ROLES, SITUATIONS, TASK-ACHIEVEMENTS, NEEDS-SATISFACTIONS SOCIAL SYSTEM NORMS AND TOTAL ECOLOGY.

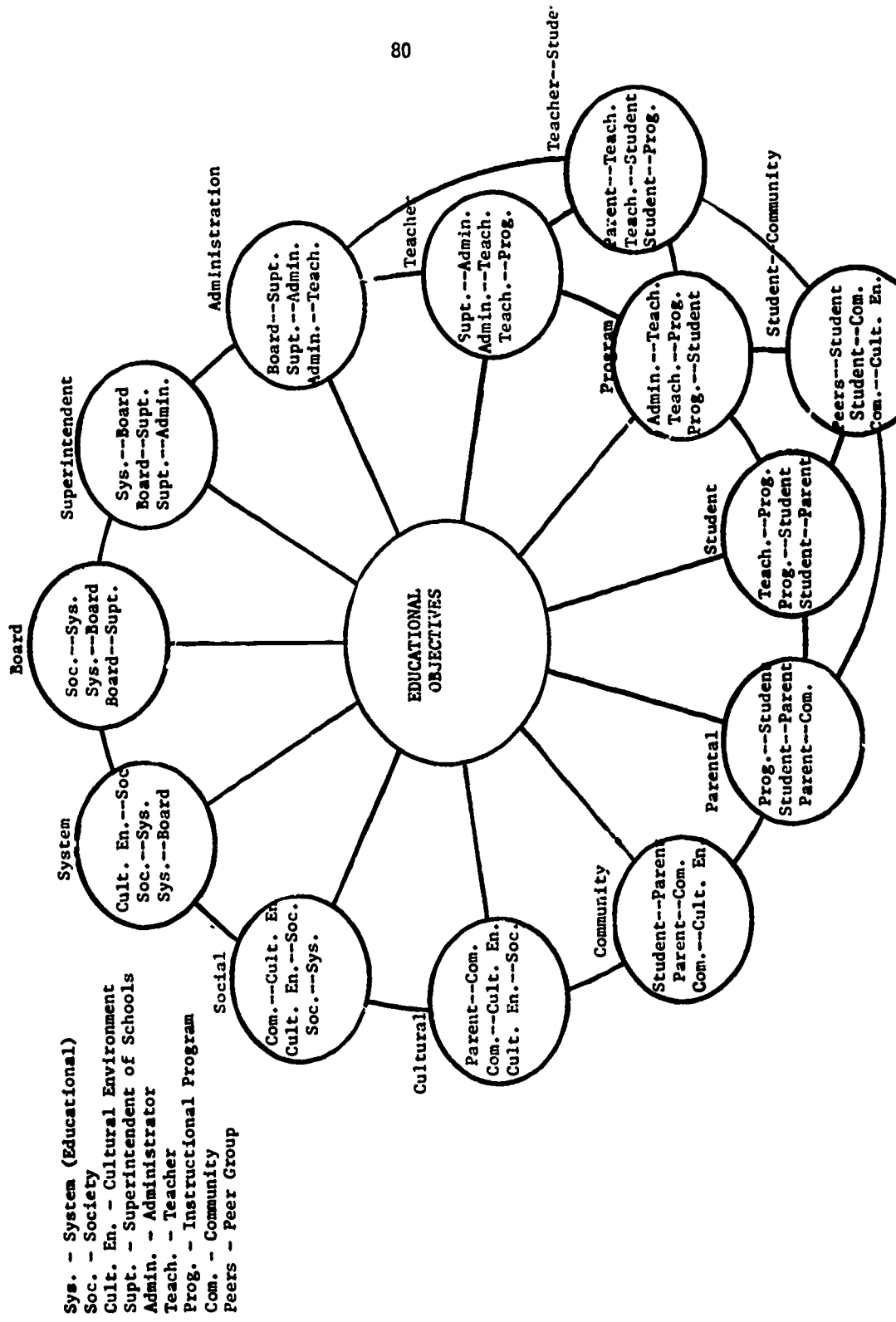


[ADAPTED FROM RICHARD C. LONSDALE, "MAINTAINING THE ORGANIZATION IN DYNAMIC EQUILIBRIUM," IN BEHAVIORAL SCIENCE AND EDUCATIONAL ADMINISTRATION. EDITED BY DANIEL E. GRIFFITHS. (CHICAGO: NATIONAL SOCIETY FOR THE STUDY OF EDUCATION, 1964.), P. 143.]

The areas of concern in performance are partially presented in FIGURE 13. Each area of concern represented in FIGURE 13 consists of the three principal interfaces which are indigenous to the area of concern under consideration. Each area of concern can be related to organizational objectives and, therefore, individuals representative of one area of concern can use this pattern of relationships to analyze the concerns of individuals located in other areas. One must realize, however, that the areas of concern represented reflect concern in relation to organizational objectives as the individual perceives them from his vantage point.

One important principle of organizational theory is demonstrated by the areas of concern presented in FIGURE 13. Each level of organization derives its functional purpose from the level of organization above it and possesses a mechanism for achieving that purpose in the level or levels of organization below it. Thus, the area of concern for the board of education can be explained in terms of three interface situations: (1) the board's purpose is derived from the interface which is effected between society and the educational system, (2) the board's principal interface is between itself and the educational system in the state, and (3) the mechanism by which the board accomplishes its purpose is demonstrated by the interface the

AREAS OF CONCERN IN PERFORMANCE Figure 13



board maintains with the superintendent of schools. An analysis of each area of concern will reveal that each area presents three principal interfaces which are indigenous to the performance area of concern under consideration.

It is interesting to note that the program area of concern interferes between the areas of concern for teachers and students. Therefore, a shunt has been developed which includes teacher-student and student-community interfaces which can be related to administration, teacher, program, student and parental areas of concern. The complexity of the relationships which exist among these areas of concern clearly indicate the multiplicity of functional interfaces which must be maintained to facilitate performance. Each individual represented by an interface will be affected in performance by the system of beliefs which serve to guide his actions.

Effectiveness

Effectiveness is an organizational quality that is achieved through satisfactory performance which produces decisive and/or desired results. Effectiveness is usually determined using value-based criteria of relevance. Thus, effectiveness determinations involve human judgments which are subject to human biases, perceptions and expectancies.

Various rationalities can be used to determine the effectiveness of organizational performance and/or performance outputs. Technical, legal, social, economic and political rationalities can be implemented to assist in effectiveness determinations. Each type of rationality can make a valid contribution to human judgment when it is utilized judiciously within the limits of its relevancy to the effectiveness determination.

Two types of effectiveness determination can be made with respect to educational system performance and/or performance outputs. First, an internal effectiveness determination can be predicted based upon an approximated set of relevant cultural values and expectations which underlie specific policy decisions. Criteria of relevance can be specified for use in making judgments relative to effectiveness. Such approximations facilitate the development of quality assurance plans which outline:

1. The desired performance proficiency levels that must be reached to be judged effective.
2. The expected levels of quality which performance and/or performance outputs should exhibit.
3. The required evaluative procedures which must be instituted in management control.

The second effectiveness determination is performed in the "real world" environment which judges educational system performance and/or performance outputs in terms of benefits to society using value-based criteria of relevance. To the extent that

quality assurance plans reflect environmental values and expectations and to the extent that desired levels of quality and proficiency are achieved; performance and/or performance outputs will be judged effective.

The need to develop reliable quality assurance plans is intensified by the accelerated rate of change that is occurring in society. Thus, effectiveness probability and reliability measures and quality control procedures will be fused into carefully structured quality assurance plans. These plans will be based upon the results of careful analyses of environmental values and expectations relative to terminal performance and/or performance outputs.

A Systems Approach to the Evaluation and Budgeting of Educational Programs:

Arnold Reisman and Martin I. Taft

The Evaluation of Programs

American education of late is being scrutinized more than ever both from within and from without. In many communities the resistance of tax payers is stiffening. The California situation, as of 1966, is but an example. Many indications point to the need for the development of some more rational bases upon which to evaluate and budget our educational programs at their various levels. The need is also felt by private and public foundations, and many government agencies in the business of distributing funds to various educational establishments for a better way of allocating their resources.

In 1965, Congress of the United States, passed the Higher Education Act, Title III of which addressed itself to some of the needs of the developing colleges in the United States. Developing colleges are considered to be those institutions which are struggling for survival and are isolated from the main currents of higher education, but which, at the same time, evidence the potential to make a substantial contribution to the educational resources of the nation. Although the act as a whole, directs higher education resources to the resolution of pressing domestic problems, it was the intention of Title III to encourage cooperation between developing colleges and stronger colleges, and between developing colleges themselves. Although over 1,000 colleges were estimated to qualify for grants under this program, only 27 million dollars was allocated by Congress. This meant that the U.S. Office of Education, the agency

charged with allocating these funds, was faced with some very grave problems of rationing. Under the auspices of the Danforth and Johnson foundations, 28 prominent educators convened at the Wingspread Conference Center in Racine, Wisconsin, to discuss Title III, its administration, and its impact on society. One of the most recurring themes heard at this conference related to the need of finding some rational, meaningful, and therefore consistent way of singling out those proposed programs which had the greatest potential for success no matter how success is defined. It was obvious to all that the money allocated if spread evenly across the board among all those seeking aid under this program would provide no impact on the institutions concerned nor on the overall objective of the act.

Similarly, at the more recent symposium "Operations Analysis in Education" which was held in Washington, D.C., November 19-22, under the auspices of the U.S., Office of Education, many speakers described the generally excellent works in applying operations analysis to the implementation of goals and objectives of institutions. However, painfully absent at this symposium, as indeed in the general practice, were those operation researchers who, addressed themselves to the setting of goals and to the setting of objectives by educational institutions, government agencies, private foundations, and so on. In fact, the reply by at least two of the speakers to questions as to "who sets the goals that they try to achieve, was unequivocally - others - the Board of Regents, the Board of Trustees, the President, and so on. We are not implying

here that it should be operations analysts who should set goals and objectives in isolation of those who are, doing so today, and are responsible for their execution. What we are calling for, however, is a closer cooperation between the two groups. By and large operations analysts have or can develop methods useful to educators if they will be made aware of the needs as felt by the latter group. A dialogue is therefore, essential. It is intended here to extend the methods already developed to the area of program evaluation.

Recognition of Need

The initial stage in the solution of any problem or the development of any program is the recognition of a need. This recognition is at first very poorly articulated, it is often a "feeling in my bones" type sensation. However, the recognition of a problem can at times be, a concern, a sense of mission, an "irritant" demanding attention and resolution. It is often stated that once a problem is well-defined, it is also well along on the path to solution. There are exceptions of course. There are those problems which are well articulated and recognized by all concerned and yet are considered to be insurmountable. There are however, many other problems which though perceived are not defined and which, are much further from being resolved than those which have passed through the articulation phase.

Problem Statement

There is a need for the setting of goals and objectives at all institutional levels and a need for all of these objectives, at all of the

levels, to be in concert with the goals of that particular institutional subsystem. Furthermore, it is necessary that the goals of a subsystem such as a department be in harmony with the goals of the next higher institutional level which in turn must have goals that are in concert with those of the institution as a whole. Moreover, criteria must be established which are in harmony with the objectives of the subsystem. In order to evaluate programs, be they new or expanding ones, we must be clearly appraised of what the goals and objectives are at all institutional levels. This is particularly true under circumstances where resources must be rationed; that is, where there is a competition for a finite amount of resources by several programs, departments, and/or projects. The problem is further complicated in situations, which are more the rule than the exception, when various competing projects, programs, and/or departments are interrelated and interdependent upon each other. It is still further complicated in those situations when the outcome of a decision is not known with certainty.

As an example, let us consider an institution which has set as its long-range goal the excellence of the learning situation. Now, the excellence of the learning situation could be achieved via several avenues. The first avenue and the traditional avenue is to seek out the most excellent classroom teachers available, weed out the mediocre ones, in order, to provide instruction utilizing the best teachers available. Another avenue might be to supplement classroom teaching with the best

audiovisual devices and methods available. Further, we may supplement classroom teaching with programmed instruction. This latter adjunct to teaching ranges from programmed texts all the way to interactive programs using large remote computers in the time-sharing mode. Furthermore, there is the alternative of either supplementing all of these items or replacing them with a fairly elaborate closed circuit TV network, perhaps in collaboration with other institutions. It should be apparent at this point that institutions generally do not put "all of their eggs into one basket." Therefore, there are inter-dependencies between the members of the faculty and the audio-visual department and/or the computer center and/or the TV network. Where to, and in what proportion should an institution's resources be allocated is a question which will now be considered.

Allocation of Resources to Programs

Our methodology requires that we define some composite utility function for learning effectiveness. We then allocate our resources in such a manner that this utility function is maximized and kept monotonically increasing at as high a rate as possible through time. The utility in this particular example might be a function of the resources allocated to the teaching staff, to the audio-visual services, to the programmed learning library of texts, to the interactive time-sharing computer capability and/or to the educational television network.

Let us denote each of these systems an "evaluation alternative." It should be noticed at this point that in the particular example we are using, as well as in many other situations, the various alternatives are heavily interrelated with each other. Specifically, the purchase and maintenance of audio-visual equipment will affect the performance of the teaching staff in increasing the effectiveness of the learning situation. Similarly, the teaching staff will make the audio-visual equipment much more useful if this staff knows how and when to use it properly. The programmed learning texts supplement and compliment the teaching staff as well as the audio-visual aids which might be available. We can thus show an interdependence between all of the factors which contribute to the effectiveness of learning.

At this stage we must recognize the existence of two distinctly different problems each requiring a somewhat different analytical approach. The first problem is that of evaluating, at a fixed point of time, the utility of a given program, department or project in relation to the aims and objectives of an institution.

The second problem is that of allocating resources to the many competing and interrelated programs, departments and/or projects so as to optimize some utility, or "payoff" function.¹ We assume here that the composite utility function U for learning effectiveness is equal to the sum of the utility functions, u_j . The u_j 's on the other

¹Arnold Reisman, "Capital Budgeting for Interrelated Projects," Journal of Industrial Engineering, XVI-No. 1: 59-64, January-February 1965.

hand are each functions of several criteria one of which represents the interdependence of the project or department being considered as an input to all other projects or departments. We shall call this particular criterion "generality" or "interdependence-output." We are basically here taking note of the fact that the output of the particular project being considered affects all the other projects; that is, this particular project has a certain rating on its generality or general usefulness.

Another criterion which we shall use to evaluate all of the projects or departments will be called "articulation" or alternately "interdependence at the input side." We note in the above example that the teaching staff is aided by all of the other factors mentioned. In this criterion we will be giving credit to each of the departments for making effective use of all other departments. A third criterion which will be applied will be that of relevance and in this criterion we rate each of the projects or departments on their individual contribution to the overall aims, goals, and objectives of an institution. In the particular example cited, the relevance of a project would be a measure of the degree to which it promotes the effectiveness of learning. Symbolically, the above interrelationships could be represented as follows. The total or composite utility of a program in terms of learning effectiveness is U . U is a function of the quality and mix of faculty, A. V. Services, Programmed Learning Text Library, Interactive Computer Capability, ETV, etc., or

$$U = u_1 + u_2 + u_3 + \dots + u_j \quad (1)$$

where the u_j 's represent the contributions to the total utility U made by the competing alternatives. Now each u_j must be evaluated with respect to several criteria such as those mentioned, namely Relevance, Generality and Articulation and so on. Thus, if c_1 is the symbolic representation for the criterion of relevance, c_2 for generality, etc., then

$$u_j = f(c_1, c_2, c_3 \dots c_n) \quad (2)$$

We apply this methodology much in the same manner as we did in the evaluation of personnel.¹ The question we now raise is as follows: how much utility is contributed by each of the programs, departments and/or projects, in a given institution to the total utility of this institution assuming the existing mix of resource allocations. Alternately, we can use the same approach to answer the question; how will the utility of a given institution change under a different mix (reallocation) of resources within a given planning horizon. Moreover, we can use the same methodology to compare the utility of one institution, at a given time, and a given resource allocation mix, to the utility of another institution of a similar class and with similar goals and objectives. Thus, from the exercises which we will delineate shortly, we can obtain inputs for the rational allocation of resources within a given

¹Martin I. Taft and Arnold Reisman, "On a Computer-Aided Systems Approach to Personnel Administration." A Paper presented at the Short Course on Recent Developments in Operation Research, Case Western Reserve University, Cleveland, June 5-7, 1968, and at the Winter Annual Meeting of the American Society of Mechanical Engineers, New York City, December 1968.

institution and/or program as well as between different institutions and/or programs. In this way, a granting agency can make institutional grants in a more enlightened fashion and the administrative bodies within the institution can make a more enlightened allocation of these funds between competing programs, projects and so on.

We proceed here as follows. We call in all those affected by a decision regarding resource allocations and those involved in the actual decision making and therefore, bearing the responsibility for such decision, to draw up a list of criteria upon which a decision is to be made. It should be parenthetically noted here that the extent to which participation is to be sought in this exercise in a given institution depends upon the tradition of the institution; that is, the position that the institution has taken in its management within the spectrum bounded by complete democracy in decision making and complete autocracy. It should be noted that this methodology is equally helpful at both ends of the spectrum. In the case of complete autocratic management, this methodology will help the decision maker to systematically evaluate all of the variables which impact his decision. However, as a general rule, it has been found that if more people who are affected by a decision participate in the decision-making process and the greater the extent of such participation, the greater is the commitment on the part of those who will actually have to carry out this decision to implement it.

In the establishment of the list of criteria upon which a given program or a department or an institution is to be judged, we may, of course, invoke the concept of "brainstorming."¹ We now ask the group to rank the list of criteria in order of the degree of importance. This procedure can be facilitated by using the Delphi methodology² a method which aids a group of experts to arrive at a consensus of opinion or subjective judgment. The next step involves weighting the various criteria relative to each other. Here, too, we can invoke the Delphi methodology if the group of participants is relatively large and/or if initially there is a fairly large difference of opinion. The last two steps may be combined into one by eliminating the ranking procedure and asking for the weighting of the criteria directly. However, there is merit in going through both steps, for it is felt that one can weight items relative to each other much easier if one has in front of him the relative order of importance.

In addition to the criteria of relevance, generality, and articulation, we might consider using a criterion such as "urgency" to satisfy pressure groups from outside the institution. It ought to be recognized, that any given institution and/or program may be under fire from several

¹George C. Beakley and H. W. Leach, "Engineering - an Introduction to a Creative Profession," the MacMillan Company, 1967, pp. 412-414.

²Olaf Helmer, "Analysis of the Future: The Delphi Method," The Rand Corporation. March, 1967, p - 3558.

pressure groups at any one time. In our weighting scheme we automatically establish a hierarchy of priorities as to what pressure groups ought to be satisfied, and to what extent. These matters are of course considered in the context of all other criteria. In this way, we have also imbedded in our methodology a "tradeoff" scheme.

Having established the criteria and the relative weights, we now ask the group to establish relationships between a score obtained by a program, department, etc. on a given criterion and the utility of this particular score to the institution. Again, this is done much in the same manner as it has been done in the context of personnel evaluation.¹ The relationships between the contributions to utility and the score received by a competitor on a given criterion is a reflection of institutional policy and objectives.

The next procedural item is to invite a group of judges to rank each competing program, department, and/or project, on a scale from zero to one hundred, with respect to each of the criteria. Here, too, we can invoke the Delphi methodology in order to obtain a consensus of expert opinion. Table I indicates a possible set of outcomes of such a procedure where three judges were rating five competing institutional programs on the basis of but three criteria, namely relevance, generality,

¹Martin I. Taft and Arnold Reisman, "On a Computer-Aided Systems Approach to Personnel Administration." A paper presented at the Short Course on Recent Developments in Operation Research, Case Western Reserve University, Cleveland, June 5-7, 1968, and at the Winter Annual Meeting of the American Society of Mechanical Engineers, New York City, December, 1968.

CRITERIA													
PROGRAMS	JUDGES	RELEVANCE			GENERALITY			ARTICULATION					
		1	2	3	1	2	3	1	2	3			
	TEACHING STAFF	95	80	85	100	90	95	100	90	100	100	90	100
	AUDIO VISUAL DEPARTMENT	80	60	70	60	50	55	50	40	45			
	PROGRAMMED LEARNING LIBRARY	70	90	80	70	85	77	60	50	55			
	INTERACTIVE COMPUTER CAPABILITY	45	80	60	50	70	60	50	40	45			
	INSTRUCTIGVAL TV	60	80	70	80	90	90	70	85	77			

TABLE I

and articulation. We might note from the numbers given that Judge 1 tends to favor the traditional approach to improving the excellence of the learning situation, namely through the use of a superior faculty. Judge 2 on the other hand, could be characterized as being a bit more of a technocrat who sees the value of programmed learning, interactive computer exercises, and closed-circuit television as being potentially capable of providing as much (if not greater) contributions to the learning process than a classroom teacher. Judge 3 is somewhat of a middle-of-the-roader between these two. The ranking on the other two criteria, namely generality and articulation are a little more difficult to come by in "one fell-swoop" than the ranking on relevance. Namely, a grade of 100 on the criterion of generality given to the teaching staff, implies that the classroom teacher makes a great contribution to the effectiveness of the audio-visual department as well as all the other departments such as programmed learning, TV, and so on: whereas, the audio-visual department contributes mostly to the effectiveness of the classroom teacher, but not so much to programmed learning nor to interactive computer capability, though it may contribute some to the effectiveness of the closed-circuit TV network.

The ratings of all of the competing departments on all of the criteria may now be combined with the utility relationships and with the weighting factors previously assigned. The calculations are described in the summary Table II. This exercise will give us both

TABLE II

$C_{j q}$	Rating given by the q 'th evaluator to the i 'th candidate on the j 'th criterion.
$u_j(C_{j q})$	The utility value corresponding to $C_{j q}$
W_j	The relative weight assigned to each criterion.
U_{ji}	The total utility score secured by candidate i for criterion j .

$$U_{ji} = \sum_{q=1}^m W_j u_j(C_{j|q}) \quad (3)$$

U_i The composite utility secured by candidate i on all n criteria

$$U_i = \sum_{j=1}^n U_{ji} \quad (4)$$

$$= \sum_{j=1}^n \sum_{q=1}^m W_j u_j(C_{j|q})$$

U The composite utility secured by all p candidates in a group on all criteria.

$$U = \sum_{i=1}^p U_i \quad (5)$$

$$= \sum_{i=1}^p \sum_{j=1}^n \sum_{q=1}^m W_j u_j(C_{j|q})$$

the utility of an institution as well as the relative contributions to this total utility score by the various departments. To answer the question of allocating resources in order to maximize our objective function (namely the effectiveness of the learning situation), we can proceed in one of several ways. In this discussion, we will present two approaches:

1. A method which moves the educational system toward achievement of its goals through time by allocating resources to a department in a manner directly proportional to its overall utility. This method is straightforward, practical and mathematically unsophisticated. It initially produces suboptimal but usable solutions.
2. A method which explicitly recognizes the interdependence between programs, departments, and/or projects. It produces analytically optimal solutions but because of a lack of mathematical sophistication in the current school setting, it has little chance of implementation.

Allocation Method 1: Maximization of Utility thru Time

In the first approach we merely ask the question, "how much do we want the utility to improve in the period of the next five years or so" and then ask, "what mix of our resources will give us the desired results?" Utilizing the total utility numbers for each evaluation alternative as weighting factors, we can transform the existing allocations into a new set of "desired" allocations which satisfied our goals and objectives. We then plot (see Figure 1) the percentage allocations which are currently used on the ordinate of a set of coordinate axes and lay off along the abscissa the various years within our planning horizon. Corresponding to year five, assuming this to be our planning horizon, we lay off the new or desired mix. Next, we connect the corresponding points with straight lines; that is we draw a straight line between the current allocations and those desired five years hence. Where these lines cross the first year mark, we pick off the allocations for the next fiscal year.

In the determination of resource allocation during the next fiscal year, we could either pick off the allocations which are straight line projections prescribed as a result of the initial determinations or we could say that we have now learned something from the experience of the first year under this scheme and we will now go through the same procedure again setting as a planning horizon again a five year period

A LINEAR SCHEME FOR RESOURCE ALLOCATION

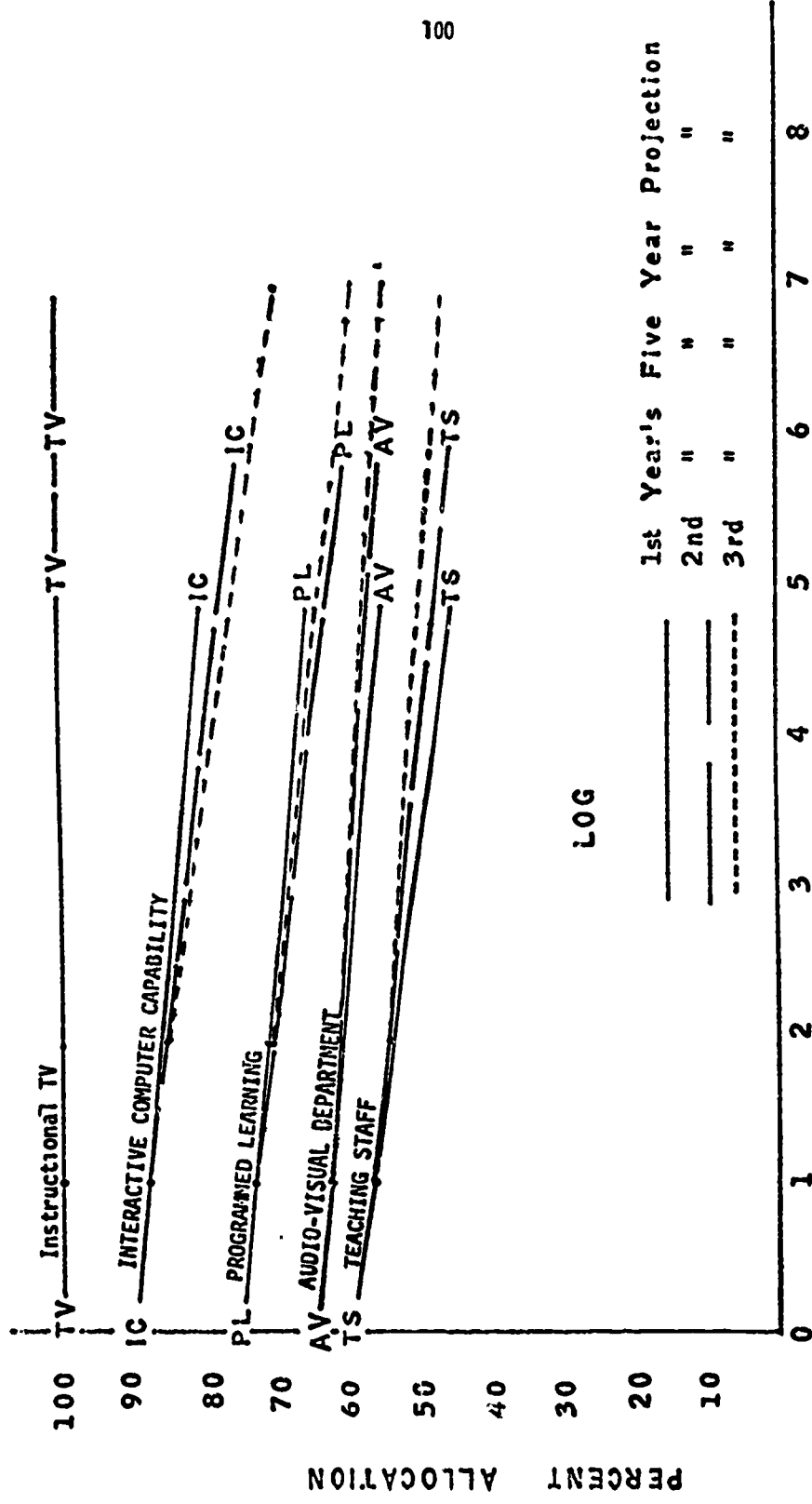


FIGURE 1

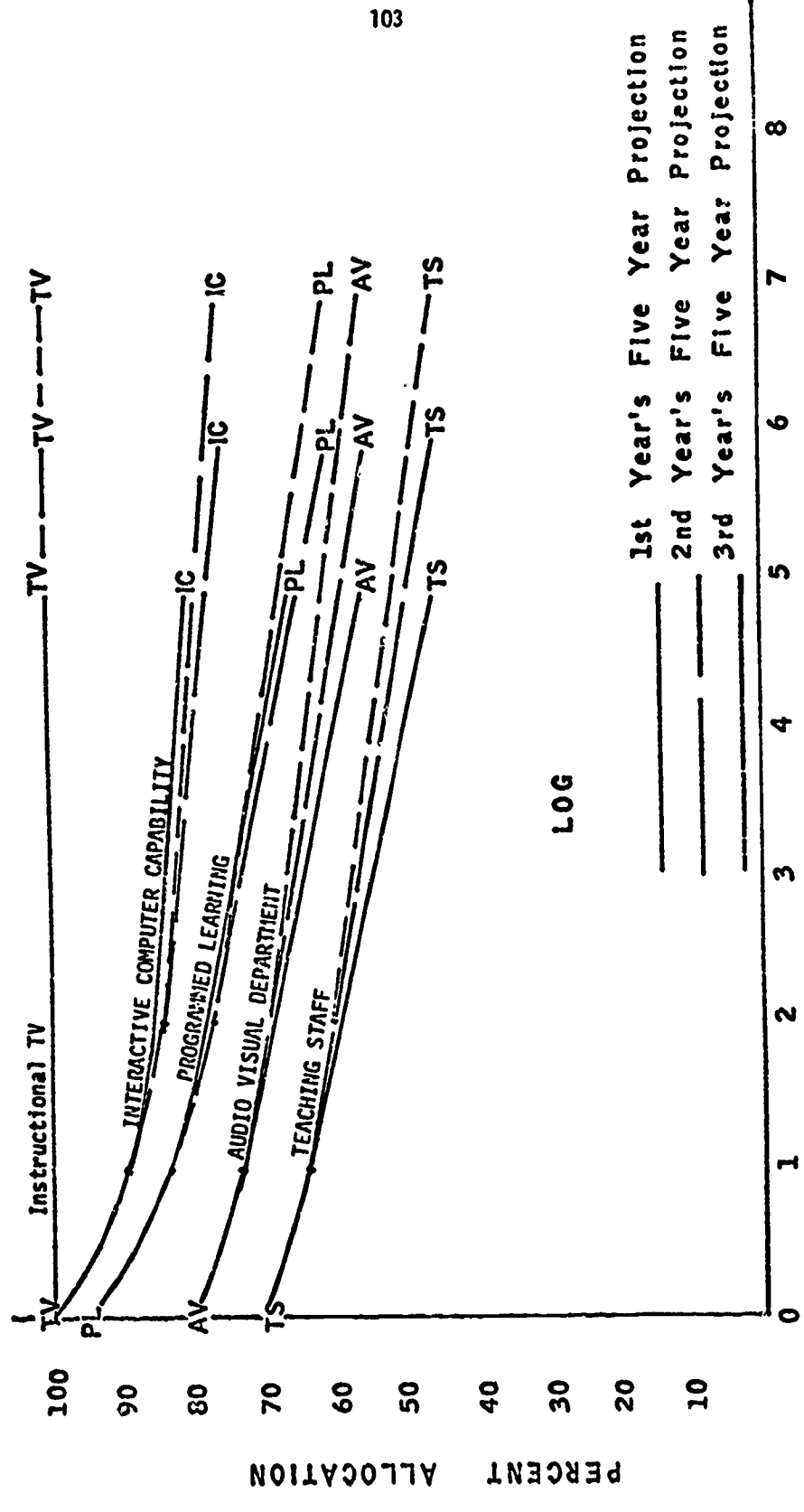
and draw the straight lines between the current allocations and those five years hence. We thus have a provision for taking into account our experiences under this method of budgeting. In effect, we have a way of adapting our system to our experiences. This latter approach has the advantages of systematic planning and systematic resource allocation taking into account all that is involved in a rational fashion. Moreover, because we have a relatively long planning horizon, and we connect our current allocations with those desired five years hence, we do not "upset the apple cart" too greatly in a given allocation determination. That is, we do take into account some of the inertias of socio-economic systems in general and those of educational institutions in particular.

The above method assumes that all of the allocations we are considering are for ongoing programs, projects, or functioning departments. However, an institution often is faced with the problem of starting up a new function, department, or project. Under these circumstances, we of course start out at time zero with a zero allocation to this particular need. If we project as we did in Figure 1 that the interactive computer (IC) capability should get 20% of the budget five years hence and recognize that the present allocation to this particular capability is zero, a straight line projection will not be satisfactory.

This is so because we generally cannot acquire a capability such as the one being considered except with a fairly large initial outlay. In these circumstances, therefore, unless we have resources from sources outside the usual budget, we must digress from a simple straight line extrapolation and now use some sort of a curvilinear projection for resource allocations over the years within our planning horizon. Figure 2 indicates how this might get done.

The reason for us departing here from the straight line extrapolation is that to get a program started, we must make an allocation which, in a relative sense, must be sizable. That is, there is some threshold minimum which we must allocate to a new program in order to get it started. This minimum allocation may reflect the purchase of new equipment, the setting up of new facilities, the hiring of new staff and so on. In the case considered, namely obtaining some interactive computer capability within an organization, it may mean all of these. Now, quite often this large input of resources to a new program is of a "one-shot" variety. That is, the resources required to keep a program running or maintaining it through time or even allowing it to grow and mature, requires a smaller per-unit-of-time allocation than is required to get it started. We thus notice from Figure 2 that in the absence of the requirement to have a program grow in major quantum jumps, we can return to our straight line projections of budget allocations with time.

A CURVILINEAR SCHEME FOR RESOURCE ALLOCATION



TIME (YEARS)
Figure 2

Allocation Method 2: Interdependence of Programs

The second question, namely that of allocation of resources under conditions where the outcome is not known with certainty and where there is an interdependence between programs, departments and/or projects has been outlined in an earlier paper.¹ In the next few pages we shall abstract² from that cited article the material which is essential to an enlightened application of the methodology leaving much of the mathematical development to Appendix I.

Assume that we have a total budget which we intend to use for allocations to a number of projects or programs. We designate the total budget with the letter N. The amount of money that we intend to allocate to a given project, say the jth project, we will designate as N_j. Therefore, the percentage of money that we intend to allocate to the jth project will be N_j/N. We will call this percentage p_j. Thus

$$\begin{aligned} p_j &= \frac{N_j}{N} \\ &= \frac{N_j}{\sum N_j} \end{aligned} \quad (6)$$

¹Arnold Reisman, Rosenstein, B. A. and Buffa, E. S. "Resource Allocation Under Uncertainty and Demand Interdependence," Journal of Industrial Engineering, XVII-No. 8: August 1966, p. 402-409.

²With permission from the Journal of Industrial Engineering.

Our problem is to systematically decide what will be the numerical value for N_j . That is to say, what will be the amount of dollars which we will spend on N_1, N_2, N_3 and so forth. Obviously, the sum of all the N_j 's is equal to the total budget N or $N = \sum N_j$.

The amount of money or resources allocated to a given project depends upon the degree to which that project satisfies a given set of criteria; in this case the criteria of relevance, generality, and articulation. Let us consider what we know about the relationship between the criterion of relevance and our allocations. Let us define the relevance of the j^{th} project as R_j . A number of relationships between the degree of relevance of the j^{th} item and the percentage of money allocated to it become immediately obvious:

1. There is some minimum percentage p_j^0 which we must allocate to the j^{th} project and or department if it is to operate at all. The j^{th} project becomes relevant only if we have allocated some minimum amount to it.

$$p_j^0 = \frac{N_j^0}{N}$$
2. As we allocate percentages greater than this minimum, we increase the relevance of this project or department to the overall enterprise. Therefore, as p_j increases, so does R_j .
3. The relevance of the j^{th} item does not increase indefinitely as we give a greater and greater percentage to it. Obviously if we gave 100% of all of our resources to the j^{th} item, we would not increase its relevance. Therefore, long before we approach a p_j of 100%, we achieve a relevance R_j which does

not increase much with increasing p's.

4. We can draw a graph of the foregoing relationships and this is shown in Figure 3. It can be seen that the graph starts out at 0, increases linearly until the allocation p_j^0 is reached and then the graph increases at an ever decreasing rate until it becomes horizontal. Thereafter, any increase in p_j does not increase the relevance of that item. We are now faced with the question regarding what the actual shape of such a curve should be. We observe that in Figure 3 we have assumed a shape which appears to be plausible but we cannot as yet substantiate it. We can describe the curvilinear part of the graph by saying that its slope decreases continuously until the slope is zero. One way in which we can decide what rules to use regarding the slope is to draw another graph. The new graph will be a plot of the slope of the first curve versus the percentage allocations p_j . See Figure 4. The slope is the rate of change of the R_j versus p_j curve and we can denote this rate by the symbol $r_j = \Delta R_j / \Delta p_j$. We know that we will start at some initial slope and then as the p's increase, we will decrease the slope until it reaches a value of zero. Since we have no reason to assume otherwise, we will arbitrarily make the points between the point corresponding to p_j^0 and the last point fall on a straight line. When we do this, and replot these slopes to correspond to individual

p_j 's on the first curve in Figure 3 we obtain the shape that we had set out to find. If we obtain new information as a result of our experience or some new theoretical considerations, we may modify this straight line curve which reflects the slope to some other more appropriate shape.

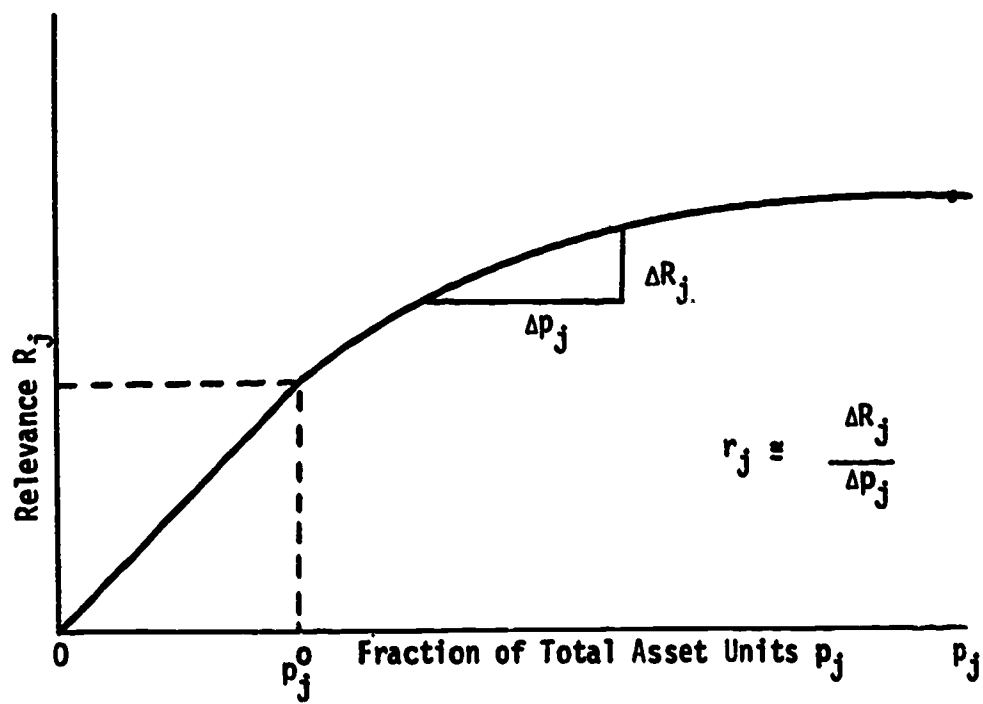


Figure 3

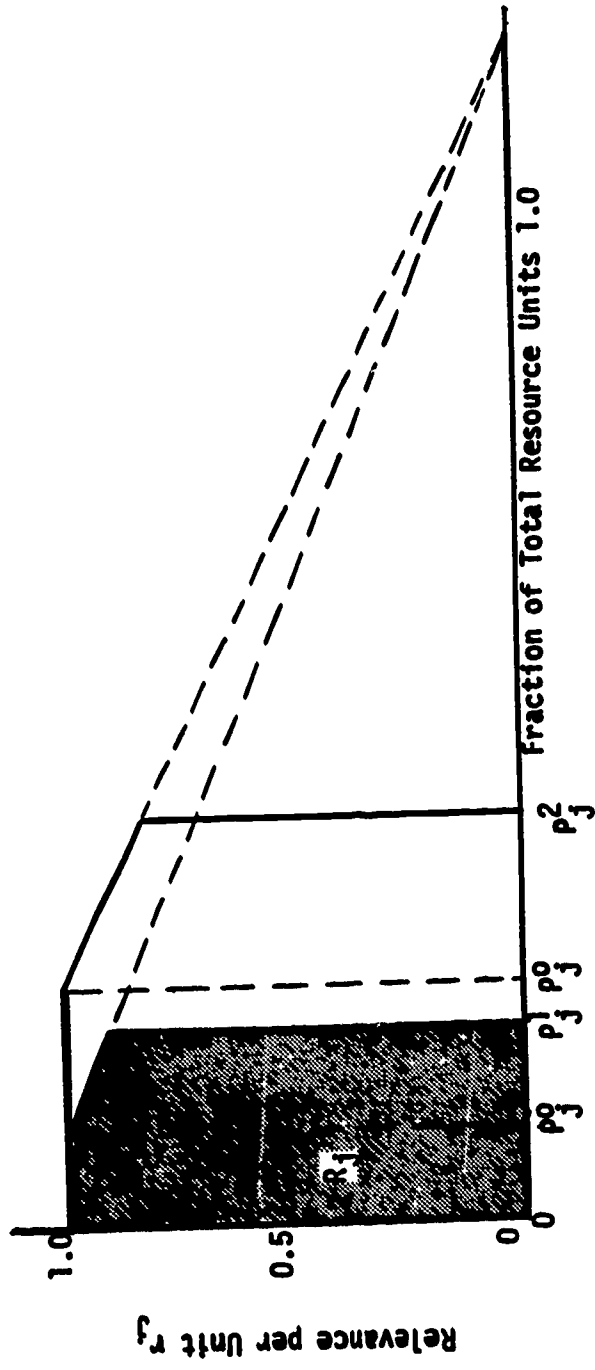


Figure 4

To decide the initial value that corresponds to p_j^0 , we can arbitrarily pick a value, R_j which is equal to p_j^0 . This means that the initial slope at p_j^0 will be equal to one and in Figure 4 the highest value of r_j will be one. We also make the assumption here that all the r 's which correspond to the respective p_j^0 's, the threshold or minimum allocations, are equal. That is

$$r_1^0 = r_2^0 = r_3^0 = \dots r_j^0 = 1 \quad (7)$$

Assumption No. 4 essentially states that as we allocate more and more resources to a given item beyond the minimum or threshold amount the additional amounts of money have less and less importance to the overall project. Another way of stating this would be to say that if the minimum amount of money required for a given project is say, \$50,000, if we were to allocate another \$10,000, that additional \$10,000 would not do as much good as any of the groups of \$10,000 that made up the first \$50,000. And this effect can be seen in Figure 3.

Also this assumption implies that the per-unity-allocation of the threshold values of relevance r_j^0 are equal.

This is justified on the basis that unless these minimum allocations are made to all projects, the entire institution might face a situation bordering on disaster.

5. For the purposes of this chapter, and in line with no other evidence to the contrary, we assume a first order linear approximation to r_j namely:

$$r_j = (1 - p_j)/(1 - p_j^0), \quad p_j^0 \leq p_j \leq 1 \quad (8)$$

However, this methodology does not preclude any other functional relationship.

The total relevance R_j of phase j is thus seen to be the area under Figure 4 or

$$R_j = R_j^0 + \int_{p_j^0}^{p_j} r_j dp_j \quad (9)$$

Equation 8 indicates that the greater the number of units assigned to the most relevant phases of a project or operations in a department, the less relevant becomes the succeeding phases or operations. One expression of the ideas in Equation 8 is given by Figure 4. Here it can be seen that all p_j 's up to

p_j^0 , are given per-unit values of relevance of unity. Above p_j^0 , the return on (or value of) additional allocation of p becomes progressively less. In Figure 4, the assumption has been made that the extension of each curve would go through zero when $p_j = 1$. This places a slight penalty upon activities with large initial p_j^0 , and as indicated earlier establishes the shape of the generalized curve of Figure 3.

We are now in a position to consider some way of measuring the other two criteria namely those of generality and articulation. The first of these two reflect the interdependence that the products or outputs of Project j will have with other projects. Whereas the articulation criterion reflects the interdependence that a Project j has on its input side, that is, the needs of Project j for the outputs of all other projects.

Scale of Generality or (Interdependence-Outputs)

Let $N_i(j)$ represent the suballocation that project j could most effectively devote to a phase that is needed in project i . One can characterize the generality of project j by the total allocation, $\sum N_i(j)$ that could be devoted to the demands of other, i , projects. $\sum N_i(j)$ can exceed N_j in practical problems. A convenient scale of generality g_j per unit of allocation can be obtained by putting

$$g_j = \sum_i N_i(j)/N_j \quad (10)$$

It must be emphasized that there is little besides simplicity and consistency to recommend Equations 10 and 11 and Equations 13 and 14 over any other scale forming and weighting equations.

Scale of Articulation (Interdependence-Inputs)

Similarly to $N_i(j)$, let $N(j/i)$ represent the suballocation which project j requires to make the most effective use of the output of project i . One can characterize the articulation of project j with other projects by the sum of units $N(j/i)$ taken over all pertinent projects i . A convenient scale of interdependence-inputs a_j per-unit allocation varying from zero to one can then be obtained by setting

$$a_j = \sum N(j/i)/N. \quad (11)$$

Interrelation of Criteria

Inasmuch as the sum of the parts cannot, in this sense, be greater than the whole, one obtains

$$\sum_j p_j = 1. \quad (12)$$

Furthermore, the average or expected values of generality and articulation taking into consideration all of the programs being considered in resource allocation are obtained by a simple weighted summation, that is

$$\langle g \rangle = \sum_j p_j g_j \quad (13)$$

and

$$\langle a \rangle = \sum_j p_j a_j. \quad (14)$$

The average or expected value of relevance for the entire institution can be stated in a fashion similar to the above, that is,

$$\langle r \rangle = \sum_j \int r_j dp_j \quad (15)$$

The methodology now requires that we maximize the relevance as expressed in Equation 15 subject to the constraining Equations 12, 13 and 14. The technique used for maximization is due to Lagrange and it is often referred to as the "method of undetermined multipliers." This method of optimization much like most others allows that only one function or one variable be optimized at a given time. This so-called "payoff function" may be quite complex with numerous weighting factors available to adjust the relative importance of the pertinent components. The calculus of optimizing Equation 15 is described in the Appendix to this chapter. The result of this calculus is Equation 16 given below. This equation prescribes the incremental allocation of resources of Project j over and above the "must" items.

$$\Delta p_j \equiv p_j - p_j^0 = (1 - p_j^0) \left(1 - \sum_j p_j^0 \right) \times$$

$$\frac{1}{n+1} \left[\frac{g_j^n}{\sum_j g_j - \sum_j g_j p_j^0} + \frac{a_j}{\sum_j a_j + \sum_j a_j p_j^0} \right] \quad (16)$$

Where n is the ratio of the weight assigned to the criterion of generality to that assigned to articulation.

In Equation 16, one can see that the first bracketed term, that is, $(1 - p_j^0)$, represents a penalty the remaining j allocations have to pay for a large value of p_j^0 . The second bracketed quantity, that is,

$$\left(1 - \sum_j p_j^0 \right),$$

represents the amount of resources to be allocated after all of the "must" items have been satisfied. Thus, with an *a priori* agreed upon distribution of a_j and g_j , weighting factor n and maximum values p_j^0 one can now proceed to evaluate the allocation of remaining resources to each project, that is, to evaluate the p_j such that the relevance of institutional operations is kept at the highest possible level with respect to the institutional goals and objectives.

Illustrative Application

Consider an institution which is composed of six departments which shall be labeled A, B, C, D, E, and F. Under existing ways of budget rationing the departments were allocated the amounts N_j of Table 3. Thus, to Department A was allocated \$19,000 of the total budget of \$104,000 and so forth. Furthermore, through a consensus of expert opinion it was judged that Department A required a minimum of \$10,000 in order to keep the institution from disaster. Similarly, the threshold figure for Department B is \$4,000. These, the most relevant allocations N_j^0 , are listed for all departments in Column 2 of Table 3 and they total \$56,000 or over half of the total budget.

Inasmuch as the departments do not operate in isolation of one another an interdependence exists among them both on the input and output sides of their operations. Table 4 lists the dollar values which expert opinion placed on the requirements¹ of Department j on the outputs of Department i. Thus, one can see that Department B requires \$6,000 worth of the outputs of Department A and Department A requires \$2,000 worth of the outputs of Department C.

Table 5 on the other hand indicates the interdependence between departments on the input side. Thus, Department A will actually use

¹ Requirements is used here in the sense that Department i must complete this amount of work before Department j can proceed with its operations.

\$2,000 worth of the outputs of Department B.

Having arrived at a consensus for the initial allocations N_j , the indispensable or threshold requirements N_j^0 , and the interdependencies $N_i(j)$ and $N(j/i)$ one more value judgment is needed before embarking on the mechanics of calculating a budget based on maximum relevance. The item to be judged is the relative weighting n of the interdependencies. Thus, β_g the weight assigned to generality or interdependence-outputs may be judged higher than the weight β_a assigned to the input side interdependence or articulation. This may be so because the functions and therefore the outputs in one department must take place before another department may proceed.

On the other hand, the items actually needed by one department which emanate from another can presumably be obtained outside the organization, thus making β_a less influential than β_g .

Assume for the purposes of this example that

$$\frac{\beta_g}{\beta_a} = n = 2. \quad (17)$$

Now proceed to calculate the values of Column 3 of Table 3, using the relationship $p_j^0 = \frac{N_j^0}{N}$; the values of Columns 2 and 3 of Table 6 using Equation 10 with data of the last column of Table 4; and Equation

11 with the last column of Table 5, respectively. Having thus arrived at the distributions of p_j^0 , g_j and a_j , the final unit and dollar allocations based on maximum relevance can be obtained through Equation 10.

The new allocations are listed in the last two columns of Table 7. Comparison of the initial allocations with the ones resulting from this analysis indicate no great changes. This condition is due to the example that was chosen, that is, a highly constrained system in which well over 50 percent of the budget was fixed by the "must" items.

Table 7
Initial and Calculated Allocations to Departments

Initial Allocations		Allocations Bas Maximum Relev	
Unit Allocations p_j	Dollar Allocations	Unit Allocations p_j	Dollar Allocations
0.182	18,900	0.21	21,800
0.086	8,900	0.12	12,500
0.240	25,000	0.26	27,050
0.146	15,200	0.11	11,450
0.086	8,900	0.10	10,400
0.260	27,100	0.20	20,800
1.000	104,000	1.00	104,000

Table 3
Total and Most Relevant Allocations of an illustrative Enterprise.

Department	Total N_j	Most Relevant N_j^*	p_j^*
A	19,000	10,000	0.097
B	9,000	4,000	0.038
C	25,000	15,000	0.145
D	15,000	7,000	0.067
E	9,000	6,000	0.058
F	27,000	14,000	0.135
Total	104,000	56,000	0.54

Table 4

$N_{i(j)}$, Sub-Allocations in Department j Needed in Department i (Interdependence-Outputs)

Department	Sub-Allocations Required by Other Departments						$\sum N_{i(j)}$
	A	B	C	D	E	F	
A	0	6,000	1,000	2,000	1,000	6,000	16,000
B	0	0	2,000	2,000	1,000	2,000	7,000
C	2,000	4,000	0	2,000	2,000	8,000	18,000
D	0	1,000	0	0	1,000	1,000	3,000
E	0	0	0	0	0	1,000	1,000
F	0	0	0	1,000	2,000	0	3,000

Table 5
 $N(i/j)$ Sub-Allocations in Department j Using the Output of
 Department i (Interdependence-Inputs)

Department	A	B	C	D	E	F	$\Sigma N(i/j)$
A	—	—	2,000	—	—	—	2,000
B	2,000	—	3,000	—	—	—	5,000
C	—	—	—	—	—	—	—
D	1,000	1,000	1,000	—	1,000	1,000	5,000
E	1,000	1,000	2,000	—	—	1,000	5,000
F	2,000	2,000	4,000	—	1,000	—	7,000

Table 6
 Values of the Most Relevant Per-Unit Allocations and Per-Unit Interdependencies

Department	p_i^*	g_j	q_j
A	0.097	0.151	0.019
B	0.038	0.067	0.048
C	0.145	0.172	0
D	0.067	0.029	0.048
E	0.058	0.010	0.048
F	0.135	0.029	0.067
Total	0.54	0.461	0.240

It is recognized that uncertainty and lack of objectivity exist as conditions under which many decisions relating to the allocation of resources are made. It does not presume to have developed a scientific theory which would eliminate such uncertainty and subjectivity. It does, however, provide a formalism which allows all projects and/or functions to compete for their share of resource allocation on a fair and equivalent, but not equal, basis. Thus, if any cheating, so to speak, is to be done, all projects have an equal opportunity to cheat. This formalism can also be used by administrators in mechanizing such decision operations if these decisions are to be made more than once.

Assuming that using either of the methodologies described, we have, at relatively high institutional levels, made the determination regarding the budget to be given to a specific department, namely that of the audio-visual department, we can now proceed to see how this subsystem would go about allocating its resources to the various competing audio-visual systems and/or components.

The Evaluation Process for Selection of a Specific Instructional Media System

We now embark upon what might legitimately be called a sub-optimization process. At a higher decision making level, we have decided to allocate resources to certain general types of systems which will tend to maximize student learning. For our illustration,

we shall focus upon the selection of specific audio-visual aids that may be used to improve learning. A major constraint to be considered is the fact that a specific sum of money has been allocated to the audio-visual department of the school for the purpose of developing the audio-visual department. To be more specific, the monies allocated are restricted for use in purchasing, maintaining, and using various types of audio-visual equipment within the entire school or university. The problem of selecting appropriate pieces of equipment and their proper mix from the multitude of products that are already on the market, constitutes a non-trivial type problem.

It is the function of the audio-visual department to purchase appropriate equipment, train technical staff as well as faculty in its use, utilize the equipment in many learning situations, demonstrate its effectiveness, and thus, create the need for more equipment and improved methods. In other words, the supply must generate the demand.

An initial crude cut at the selection of major pieces of audio-visual equipment or specific audio-visual systems can usually reduce a very large number of alternatives to a smaller more manageable set. This can be done on the basis of excessive costs, minimum effectiveness, a lack of highly developed software, immediate delivery, or other similar criteria. The elimination process can be considerably streamlined by for all of the systems under consideration their costs per user per year, and other relevant information such as guidelines developed by experts in the A-V field. The items remaining after such

a crude, intuitive analysis are shown in the typical table given as Table 8.

The synthesis of an initial list of equipment alternatives is predicted upon the assumption that the long-range goal of an audio-visual department is similar to the one postulated at higher levels, namely to enhance the learning process. In a more specific formulation, we might state that the long-range goal of the audio-visual department is to provide all units of the educational institution with appropriate supporting resources such as equipment, trained personnel, and information in the "best mix" and at the right time and place. This goal may be further amplified and delineated in terms of a set of departmental objectives such as:

1. To purchase, maintain, and distribute a variety of instructional media (equipment and materials) which will support the instructional programs of the institution. This objective is to be fully operational within two years.
2. To develop and offer in-service courses in the theory and use of instructional media which will be operational within one year.
3. To maintain a research and development program which is aimed at continuing analysis of existing media technology with major emphasis on improving existing media and developing more effective hardware and software.

B

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EQUIPMENT NAME	COST x 10 ⁻⁵ unit of usage	Major Functions, Features, and Special Specifications	BASIC (by end of second year)	ADVANCED (by end of fifth year)
1. 16 MM Projector (motion picture)	39	Total cost: \$600; Life Expectancy - 5yrs.	1 per teaching stations (multipurpose institution)	1 per 8 teaching stations
2. Combination Manual Slide & Film Strip Projector	6	Total cost: \$120 Lf. Exp. - 10yrs.	1 per 10 teaching stations	1 per 6 teaching stations
3. 2-2 Slide Projector	11	Total Cost: \$150 Lf. Exp. - 5 yrs.	1 per 10 teaching stations	1 per 5 teaching stations
4. 3-4 Slide Projector	79	T. C.: \$300; Lf. Exp. - 10 yrs. 1 projector @\$280; 1 polaroid camera @\$100	1 per auditorium	1 per auditorium plus arc or similar power
5. Record Player	5	Total cost: \$80 Lf. Exp. - 3 yrs.	1 per 25 teaching stations	1 per 15 teaching stations
6. Overhead Projector	100	Total cost: \$225 Lf. Exp. - 5 yrs. 1 proj. @\$200; 1 thermofax secr. @\$200; 1 Primary typewriter @\$380	1 per 4 teaching stations	1 per teaching station
7. 8 M Projector	12	Total cost: \$230; Lf. Exp. - 5 yrs. Cartridge Proj. (silent) @\$100; 1 reel to reel sound proj. @\$450; 1 camera @\$200.	1 to 3 sound projectors per institution	1 per 10 teaching stations
8. Opaque Projector	5	Total cost: \$350; Lf. Exp. - 10 yrs.	3 to 6 per institution	8 to 12 per institution

9. Video Tape Recorders	11	Total Cost: \$2,500 Lf. Exp. - 3 yrs. 1 VTR; 2 micro-phones & stands; 1 Video Monitor; 1 Audio Mixer; 1 camera with zoom lense & tripod.	1 per institution	1 per TV Production Unit
10. Audio Tape Recorder	79	Total cost: \$180 Lf. Exp. - 3 yrs.	1 per 5 teaching stations	1 per 2 teaching stations

Table 8. - Initial List of Equipment After Comparison and Elimination of "Obviously" Unacceptable Items.

4. Develop and maintain an institutional quality-control program in instructional media.

With these ideas in mind, we approach the problem of selection of specific equipment or systems of equipment from the point of view of decision theory and utility theory. Our objective is to make the best decision possible. From the point of view of utility theory, we would like to select that particular alternative system or equipment which will offer the greatest overall utility or value to the audio-visual department and ultimately to the entire educational institution.

When we consider the potential contribution of any alternative audio-visual system to the objectives of the institution, we usually assume that the world and the educational system under consideration will operate in a particular manner. Since we are usually not crystal ball gazers, we cannot predict exactly how the world will be in the future. We can only make reasonable estimates or educated guesses based upon the best opinion of knowledgeable people. One reasonably efficient way in which a very small number of sets of future conditions can be deduced from the infinite number of futures that are possible, is to obtain the written opinions of people closely related to the field of education. A set of possible future conditions is known in the literature as a "state of nature."

The group of "experts" might be requested to limit their statement to no more than one hand-written page and to write down

between one and five possible major directions that the educational institution might take over the next 5 years. The conditions (states of nature) that are selected ought to be relatively independent of each other. In addition, the experts might be asked to estimate the probability of occurrence of each of the alternatives that they foresee. The sum of all of their probabilities must add up to 1.00. We must, therefore, assign to each alternative audio-visual system some overall utility number which represents its total value to the institution on all criteria and all major states of nature. In short, we must fill in numbers in the general decision matrix for audio-visual systems under consideration as shown in Table 9. Table 9 lists the various alternative systems that we are considering and shows that out of all of the possible states of nature which may occur in the future, we shall only consider three, namely s_1 , s_2 , s_3 .

A list of all of the suggested states of nature may then be compiled. Staff members of the audio-visual department or instructional media division, may then combine similar suggestions, eliminate redundancies, and arrive at a small number of representative alternative states. The key question to be asked during this process is, "Are the states of nature under consideration, sufficiently independent and different from each other so that a different selection and 'mix' of equipment would be appropriate for each of them?" In other words, would we select one set of equipment if state 1(one) occurred, and a

different set of equipment if state 2 (two) occurred. If it is concluded that no major significant changes will occur in the educational institution in the foreseeable future, (say, over the next ten to fifteen years) then the analytical work is considerably simplified. It is then necessary to consider only one state of nature; namely, a set of conditions which are substantially similar to those existing at the "present" time.

A typical set of states of nature resulting from the foregoing process for obtaining a group's opinion, with respect to alternative future states of nature, is presented in Table 10. It can be seen that the second state s_2 , is taken as a reference state and concisely referred to as the "status quo". The second state represents the condition where school policies and structures remain essentially unchanged. The third state, s_3 , assumes that there will be a significant increase in the percentage of students entering our educational institutions and continue their education. It further assumes that the supply of teachers will not be able to keep up with the demand and will, in fact, fall further and further behind. This condition will force a greater reliance upon mass education approaches learning, methods, and equipment. It also assumes that educational standards and admission policies will drop and the amount of money spent on each student per year, will also decrease as time goes by. Finally, state one, s_1 , reflects a view of many educators and knowledgeable experts in the field of education, that there will be increasing emphasis on

TABLE 9 GENERAL DECISION MATRIX FOR AUDIO-VISUAL SYSTEMS

PROBABILITY OF OCCURRENCE OF STATE OF NATURE S_n, p_n	COMPOSITE UTILITIES FOR VARIOUS STATES OF NATURE, S_n			Expected Total Utility
	S_1	S_2	S_3	
ALTERNATIVE SYSTEMS	"Individualized" p_1	"Status Quo" p_2	"Mass Education" p_3	U_i
1. 16 MM PROJECTOR	U_1^1	U_1^2	U_1^3	U_1
2. FILM STRIP PROJECTOR	U_2^1	U_2^2	U_2^3	U_2
3. 2-2 SLIDE PROJECTOR	U_3^1	U_3^2	U_3^3	U_3
4. 3-4 SLIDE PROJECTOR	U_4^1	U_4^2	U_4^3	U_4
5. RECORD PLAYER	U_5^1	U_5^2	U_5^3	U_5
6. OVERHEAD PROJECTOR	U_6^1	U_6^2	U_6^3	U_6
7. 8 MM PROJECTOR	U_7^1	U_7^2	U_7^3	U_7
8. OPAQUE PROJECTOR	U_8^1	U_8^2	U_8^3	U_8
9. PORTABLE VIDEO TAPE SYSTEM	U_9^1	U_9^2	U_9^3	U_9
10. AUDIO TAPE RECORDER	U_{10}^1	U_{10}^2	U_{10}^3	U_{10}

NOTE: $U_i = \sum_{k=1}^n p_k U_i^k = p_1 U_i^1 + p_2 U_i^2 + p_3 U_i^3$
 where $i = 1, 2, 3, \dots, 10$ (18)

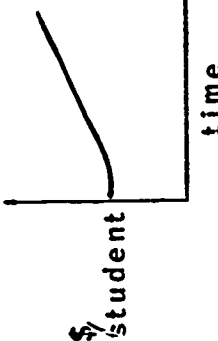
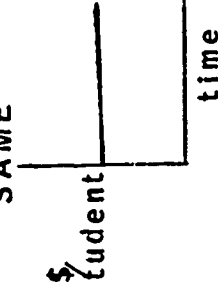
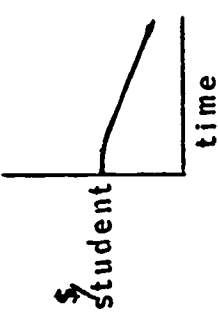
STATE OF NATURE, S_n		S_1	S_2	S_3
Probability of S_n , $n = 1, 2, 3$		$P_1 = .15$	$P_2 = .50$	$P_3 = .35$
<u>MAJOR ASSUMPTIONS</u>				
Educational Policy		INDIVIDUALIZED EDUCATION Increasing emphasis on individual learning; school moves toward "continuous progress" concept.	STATUS QUO School policy to remain essentially unchanged regarding educational system structure; a potpourri of methods and approaches.	MASS EDUCATION Significantly greater use of mass-oriented methods, approaches and equipment; emphasis on group (large) learning.
School Admission and Education Standards Availability of Resources for Maximization of Student Learning		INCREASE 	REMAIN THE SAME 	DECREASE 

Table 10. - Summary of three possible future states of nature relevant to decision-making with regard to instructional media and the estimated probability of their occurrence.

the individual learner. Under this state of nature, more money will be spent per student; more people will receive much more individual attention from their respective teachers but only when needed. The student will proceed through the educational institution at his own speed and will accept the major responsibility for his own learning.

Although many other states of nature are conceivable, the three states mentioned above offer policy makers a set of relatively independent alternative directions in which their institution may go. Any educational institution may conscientiously attempt to make any one of these three states a reality. It should be noted, that in general, it should not be expected that some or all of these states can realistically exist in one educational institution at the same time. While it is possible to introduce, individual features of a given state in another state, broadly speaking, they are mutually exclusive. The probability of occurrence of the three states, may be obtained by use of the Delphi method, or any other methodology which reflects a consensus of opinion of the persons involved. For the purposes of illustration, it can be seen in Table 10 that state S_2 is assumed to have a probability of occurrence of 50%, state S_3 has a probability of 35%, and state S_1 is least probable at 15%.

After deciding upon a set of alternative items or systems of equipment that are to be evaluated, as well as a number of states of nature under which each of the alternative systems may operate, it

is necessary to find a total utility number for each system and for each state of nature. The total utility of a given alternative, is equal to the sum of the utilities for each evaluative criterion. We shall set up a list of criteria by which we will evaluate every alternative piece of equipment. Since each criterion is not equally important to the institution in terms of achieving its objectives, we will assign weighting factors. This implies that some criteria will be more important under one state of nature than under others. In addition it will be necessary to relate any rating that is given for a specific criterion to the objectives of the institution. This can be done by developing a set of utility curves or relationships. Any rating assigned to a criterion has a corresponding value to the institution which we call a utility. By drawing utility curves we make these relationships explicit and hopefully, consistent, for each alternative that is to be evaluated.

All of the aforementioned data inputs to the analysis are summarized in Table 11. The ten criteria given in Table 11 are typical of those used by faculty and staff in evaluating various alternative audio-visual systems. We shall briefly indicate the intended meaning of each of these criteria and the procedure for arriving at the numerical ratings.

Effectiveness - The criterion of effectiveness is the most important, and ironically, the most difficult

criterion to assess. When we rate a piece of equipment with respect to its effectiveness, we are attempting to gauge the degree to which this particular item aids the learning process as compared to any of the other items with which it is competing. At first glance it would seem that this is an impossible task because we are trying to compare items that are quite different in nature. It is like comparing apples with pears or peaches. While the problem may be difficult it is not insurmountable. We can begin by developing an ordinal scale. This means that we "order" all of the items from the one that we consider most effective, in helping the learning process, to the last item, which we consider the least effective by comparison to any of the others. We can ask an experienced group of people to carry out this ranking process and we would usually find that considerable agreement is obtained with respect to the order of all of the items. There will be some differences of opinion but these can be reduced through the use of an iterative voting process like the Delphi Method. It is certainly possible for people to state that

an overhead projector is in general more effective than an opaque projector; that a tape recorder is in general a more effective tool than an AM-FM radio in the classroom; and that a 16 mm. motion picture projector is more effective than an 8 mm. projector.

After the items have been ranked, we can convert the ordinal scale into an interval scale by estimating the degree to which one item is more effective than another. The most straightforward way to accomplish this, is to assign a numerical value, (say, 100) to the most effective item. We then ask an appropriate group of evaluators to assign relative values to each of the remaining items. How much less effective is the second item by comparison to the first, which has now been rated 100? Is its effectiveness 95, 90, 88, 60? We can place a lower limit on effectiveness by asking whether the last item on the list is half as effective as the first item. If it is, then we would assign it a value of 50. If it is a quarter as effective, we would assign it a value of 25, and so forth. The Delphi method can be used to minimize differences of opinion with respect to any particular item.

- Versatility -** This criterion is a measure of the number of advantages that a given item may have compared to other items for a given purpose.
- Ease of Operation -** In this criterion we are attempting to measure the relative ease with which it is possible to operate the equipment by comparison with other items. The simpler an item is to operate, the greater is the probability that it will be used. Thus, in terms of ease of operation, a record player would be rated higher than a portable video tape system.
- Accessibility -** This criterion is intended to provide an estimate of the degree to which a given piece of equipment is available for use by faculty and/or students. The degree to which a given item is accessible to the user is an important factor in determining the degree to which the item helps in the learning process. Some items require for their operation, that an audio-visual specialist be available at all times in order that the user may profitably gain the benefits of this tool. On the other hand other items can be taken home by the student, checked out of a library, or made readily available in the classroom without any staff help. Some items might be available at all hours of the day,

whereas others might be available only when school is in session, or during normal working hours.

Cost per user per year - Since every equipment item has a different initial cost as well as operating and maintenance cost, it is difficult to evaluate them merely on a dollar basis. By dividing the cost of an item by how many people will be using it during the course of a year, we provide a more effective cost measure for comparison between items.

Technological Viability - In selection of equipment, it is important to consider the possibility of obsolescence. Items least likely to become obsolete in the near future should be given more consideration.

Physical Durability - This criterion is intended to take into account the physical, structural, mechanical, electrical, etc., durability aspects of the equipment.

Maintainability - This criterion is concerned with the availability of service facilities and/or replacement parts.

Multi-purpose Use - This criterion rates equipment on the degree to which it may be used in a variety of ways and in conjunction with other audio-visual aids.

Attractiveness - This criterion is intended to provide some estimate of the degree to which a manufacturer has considered the human factors in the design of the equipment.

The criteria shown in Table 11 have been ranked for illustrative purposes, with respect to their relative importance in achieving the objectives of the institution. In columns 2, 3 and 4, each of the criteria have been assigned a relative weight for each of the three states of nature. If the "status quo" state of nature is taken as a reference state, it can be seen that in general, if the institution moves in the direction of more individualized approaches to learning, all of the criteria will assume greater importance. On the other hand, if the institution moves in the direction of policies and programs which are mass-education oriented, then many of the criteria will assume lesser importance. The numerical values for the relative weights were determined by the methods described earlier.

The ranges of possible values (ratings) which may be assigned to each criterion for a given alternative system, are shown in column 5 of Table 11. It can be seen that all of the ranges are from 0 to 100. Any other range of numbers such as 0 to 10, or 1 through 5, would have been acceptable. The range of values for "cost per user per year" is determined by taking a number which is approximately 20% lower than the lowest cost per user per year that we are considering and using a number 20% higher than the highest number, under consideration. Since the ratings that we use for this criterion are determined empirically, we call this a "tangible" criterion.

The numbers presented in columns 6 through 11 of Table 11 represent critical sets of criterion - utility data points. Our objective is to

MAJOR CRITERIA, C_x	Relative Weight			Range of C_x	Critical Criterion Ratings and their Corresponding Utility Values						Utility Curves (Relationships)
	S_1	S_2	S_3		c_L	u_L	c_A	u_A	c_H	u_H	
	W_1	W_2	W_3								
1. Effectiveness	120	100	120	0-100	20	0	50	50	92	100	
2. Versatility (Relative Advantages)	100	95	100	0-100	0	0	60	40	96	100	
3. Ease of Operation	98	90	85	0-100	0	0	50	60	100	100	
4. Accessibility	97	85	80	0-100	0	0	50	50	100	100	
5. Cost Per User	85	80	70	0-100	0	100	50	50	90	40	
6. Technological Viability	83	78	68	0-100	30	0	50	60	92	100	
7. Physical Durability	80	75	65	0-100	0	0	40	80	80	100	
8. Maintainability	80	75	65	0-100	0	0	50	50	100	100	
9. Multi-Purpose Use	60	50	45	0-100	0	60	50	60	100	100	
10. Attractiveness	45	30	15	0-100	10	0	50	60	90	100	
	2	3	4	5	6	7	8	9	10	11	12

TABLE 11 - A summary example of the input information required to perform a utility analysis with respect to audio-visual equipment and/or systems.

produce a set of explicit utility curves which are shown in column 12 of Table 11. The numbers in columns 6 through 11 provide sufficient information for plotting three points on each graph. The c_L values represent the lowest ratings that may be assigned to give criterion below which the corresponding utility value will not change. The u_L values correspond to the c_L 's. The c_A and u_A values correspond to expected "average" ratings. Finally, the c_H and u_H values represent corresponding pairs of numbers which represent data points past which the numerical values of the u_H 's will not change or points which correspond to the maximum value of the criterion in question.

After the three critical points have been plotted on their respective utility graphs, the final utility curves are determined by assigning some additional points in the vicinity of each of the critical points. The final shape of the curves then becomes obvious and can be drawn in with relative ease. All of the points as well as the exact shape of the utility curves, may, as before, be determined by means of the judicious use of the Delphi method or any other method for obtaining a consensus of opinion with regard to the issues at hand. Once all of the utility curves have been developed, it is possible to proceed to the actual evaluation, or rating of each of the alternative audio-visual systems.

Evaluation of Audio-Visual Equipment

When an audio-visual department is initiated, the evaluation of

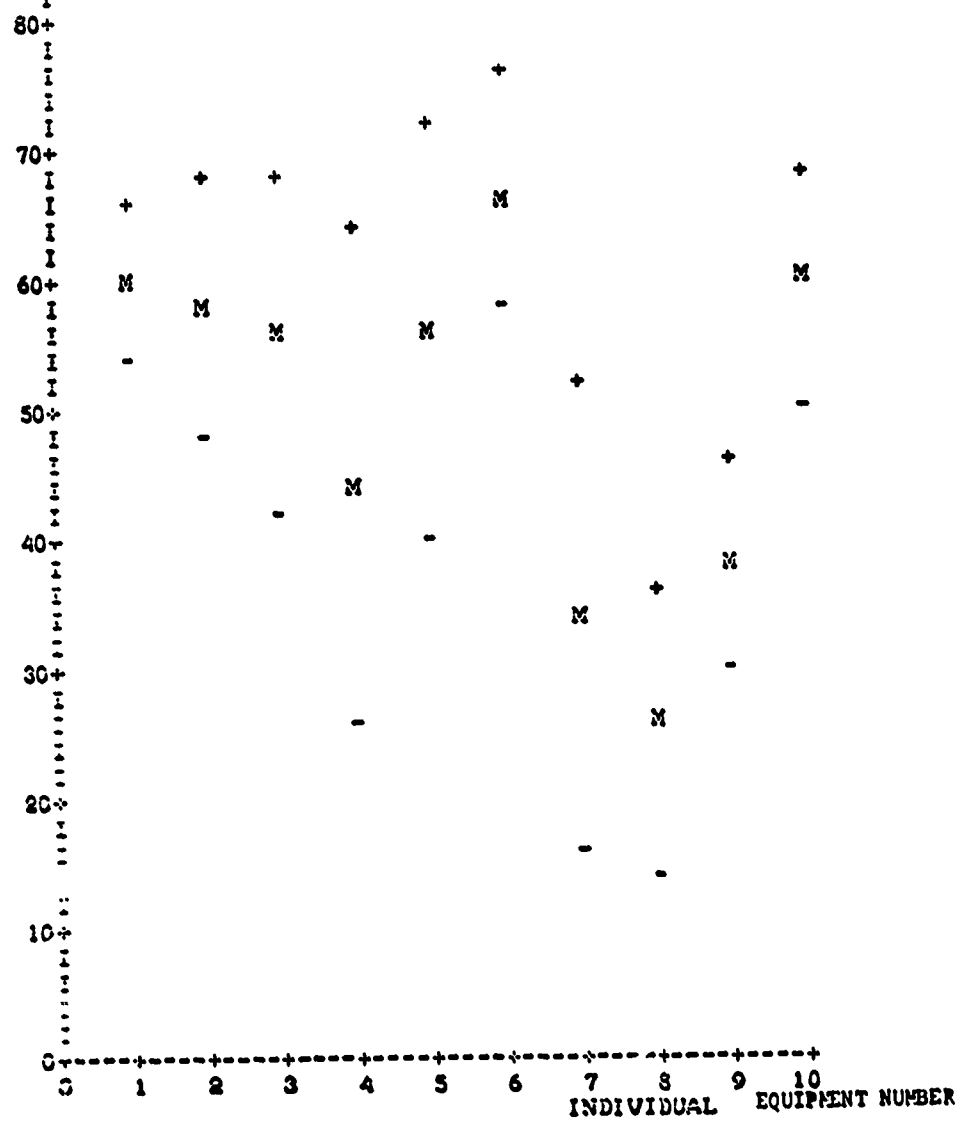
equipment is done mainly by utilizing subjective judgments based upon experience at other institutions, recommendations of national committees on audio-visual aids and/or of consultants. Since one of the major tasks of such departments is to generate a need within the educational institution for audio-visual equipment there is usually very little empirical data that may be used in making the evaluation. Under such circumstances, we are forced to rely upon the subjective judgments of knowledgeable people. It is assumed that ratings obtained by means of a consistent and repetitive procedure and subject to explicitly stated goals, objectives, criteria and institutional constraints, are more useful than none at all. Therefore, each evaluator (judge) is requested to rate each of the alternative pieces of equipment with respect to the first criterion; then to rate each of them with respect to the second criterion; and so forth. By means of this procedure, we tend to minimize the effect of any prejudice that an evaluator may have for and against a given piece of equipment.

Each numerical rating given by an evaluator to a candidate system on a particular criterion may be converted to a "utility" number by referring to the corresponding utility graph for the criterion in question. Since the utility values obtained on one criterion are not necessarily of the same importance to the institution as that of another criterion,

10.0
UTILITY SCORES

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+ = 1 positive standard deviation
M = mean total utility
- = 1 negative standard deviation



- | | |
|-------------------------------------|-------------------------------|
| 1. 16MM PROJECTOR | 6. OVERHEAD PROJECTOR |
| 2. FILM STRIP PROJECTOR | 7. 8MM PROJECTOR |
| 3. 2-2 SLIDE PROJECTOR | 8. OPAQUE PROJECTOR |
| 4. 3 ^{1/4} SLIDE PROJECTOR | 9. PORTABLE VIDEO TAPE SYSTEM |
| 5. RECORD PLAYER | 10. AUDIO TAPE RECORDER |

FIGURE 5 - Computer Output: A graphical comparison of the relative total utility of 10 types of AV Equipment with respect to 10 evaluation criteria.

we multiply each utility number by its corresponding weighing factor. This places all of the utility numbers on the same scale and they may now be added together. The addition process yields a composite utility of each alternative system by each evaluator.

The foregoing ratings were assigned by each evaluator under the assumption of one particular state of nature. Obviously the same process can be repeated assuming that the other two states of nature are true. In the end, we will have obtained three sets of composite utility numbers; one for each state of nature. The expected total utility of a given alternative system when evaluated by a particular judge can be obtained by finding the product of each composite utility number and its corresponding probability number, and adding the products together. In this way, we will have a set of expected total utility numbers for all of the alternative systems under evaluation from each judge. We might expect that the judges will differ in their ratings of each alternative system and therefore, the final sets of numbers obtained from each of them will be distributed about a set of means values. We can average corresponding sets of values together to obtain the means, and then calculate one standard deviation on each side of these mean. All of the aforementioned calculations and procedures have been implemented on a time-sharing digital computer system and the final results are shown in Figure 5.

The graphical comparisons shown in Figure 5 indicate that based on

the evaluation of one group of "experts" the most useful audio-visual system is the overhead projector with a total utility of 68; whereas the opaque projector has the least utility with a value of 26. The plus and minus signs give an indication of the degree to which in the given sample of "expert" opinion, there is agreement with regard to the overall utility values. These results give a quantitative indication as to how resources should be allocated. It indicates which alternative systems should not only receive great allocations with respect to hardware, but also receive emphasis with regard to the allocation of personnel and the development of software. If such an analysis were to be made periodically, say yearly, and was to be formally combined with idealized guidelines as well as data regarding the actual demand for equipment over a period of years, a powerful planning, purchasing, and administrative tool would become available. It is to the development of such a tool that we will address ourselves in the next section.

Allocation Decisions

The decision regarding the amount of money to allocate to each type of audio-visual equipment or system is dependent upon three major factors. The first factor which influences our decisions is represented by the "guidelines" developed by national organizations in the field of audio-visual instruction. This factor plays a dominant role during the first few years of an audio-visual program. During these years, very little data exist regarding the instructional needs of the institution and the

demand characteristics of the given educational system. After a few years, however, it becomes possible to rely upon empirical data rather than guidelines which represent average demand characteristics in similar institutions. The second factor which should affect our allocation is the estimated relative importance or total utility of each item to the institution. This factor influences our decision by indicating what "should" be the distribution of resources in order to maximize the effectiveness of the audio-visual program to the institution. Initially, determination of the total utility of each item is based upon experience at other institutions. As the years go by, however, the utility analysis comes to reflect more and more the actual characteristics of the institution in question. The national guideline can be used to set allocation objectives for the first few years, e.g. five years, and then be phased out in favor of the utility analysis. The third factor which influences the allocation of resources is the actual demand for equipment in the institution. We might expect that the supply of equipment should be roughly proportional to the demand. The demand (use) for equipment depends upon its availability (supply) and the degree to which the item is supported in terms of software, training courses, and publicity in the audio-visual program. If an audio-visual department takes its own utility analysis seriously, and proceeds to emphasize those pieces of equipment that the analysis shows to be of greatest importance to the institution, then it may be expected that the item will have a

steadily increasing demand for its use. On the other hand, those items that have low utility would tend to be less emphasized in the programs and activities of the department and would have a correspondingly lower demand.

The method for obtaining the actual allocation for each item for a period of years is given in Table 12 and in the graphical representation of Figure 6. The ideal initial allocation, A_i , for each item is based upon the minimum equipment recommended in a set of guidelines. Such guidelines will usually state that for a piece of equipment, such as an overhead projector, there should be one item for every ten teaching stations. A teaching station is defined as a classroom or laboratory. In an institution having two hundred teaching stations initially, the initial ideal allocation would be \$4500 if the individual item cost was \$225. This calculation is carried out in column (3) of Table 12. The sum of all the initial ideal allocations is the ideal initial budget, (IIB). To determine what percentage of this ideal initial budget we would like to allocate to each of the competing items, we utilize the total utility values as weighing factors. Thus each A_i is multiplied by the corresponding U_i and divided by the sum of all the $(U_i A_i)$'s. The resulting numbers are called weighed percentages. The desired initial allocation, (DIA), for each item is obtained by multiplying the weighed percentages by the sum of the corresponding ideal initial allocations, A_i . The results are shown in column (4) of Table 12. The sum of all the desired initial

allocations is equal to the desired initial budget.

Quite often the funding is less than the requested budget. In such cases, we are faced with the problem of deciding how to apportion these funds in a manner that will do as little damage as possible to the effectiveness of the entire audio-visual program. A number of possible approaches to this problem immediately come to mind. Three of them are shown in Table 13. Each approach to this problem, which may be stated as a decision rule has some advantages and disadvantages. The alternatives are stated explicitly in Table 13 and a modification of the first decision rule is used in the calculations presented in column (5) of Table 12. In this case, it was decided to purchase the most important items and to purchase only one of each of those items of lesser importance, at least for the present time. In this way, every piece of equipment may at least be demonstrated and used for purposes of comparison. It is also assumed that initially there is no demand for any piece of equipment. Usually this is not quite true. An audio-visual department is not set up the first day an institution comes into existence. The institution is usually functioning for some time before funds are allocated to such an activity. Therefore, there is probably some small demand for a small number of well-known standard items such as the 16 MM projector or a record player. Since the initial purchases of the audio-visual department will easily satisfy this small demand, we omit the demand from the foregoing calculations. In Figure 6

TABLE 12

Names of Items In Ranked Order	Total Utility Score, U_i	Ideal Initial Allocations, A_i based on "Minimum Guidelines" (I.I.B.)	Desired Initial Allocations, (D.I.A.) _i Modified by utilities	Actual Initial Allocations (A.I.A.) _i using first Decision Rule
OVERHEAD PROJECTOR	68	\$4500	\$5734	\$5734
16 MM PROJECTOR	60	8000	9000	9000
AUDIO TAPE RECORDER	60	2400	2700	2700
FILM STRIP PROJECTOR	58	960	1040	120*
2-2 SLIDE PROJECTOR	56	1500	1574	150*
RECORD PLAYER	56	400	420	80*
3-4 SLIDE PROJECTOR	44	1200	990	300*
PORTABLE VIDEO TAPE SYSTEM	38	5000	3560	2500*
8 MM PROJECTOR	34	920	584	230*
OPAQUE PROJECTOR	26	1400	680	350*
TOTALS	500	\$26,294 = $\sum A_i = 118$ Assuming 200 teaching stations	\$26,294 = Desired Initial Budget	\$21,164 = $\sum (AIA)_i$ = Actual Budget Spent

(19) $A_i = (1 \text{ item/teach. sta}) \times \# \text{ Teaching stations} \times \frac{U_i}{\sum U_i} A_i$ * One item of each type was purchased for demonstration purposes.

FORM C3

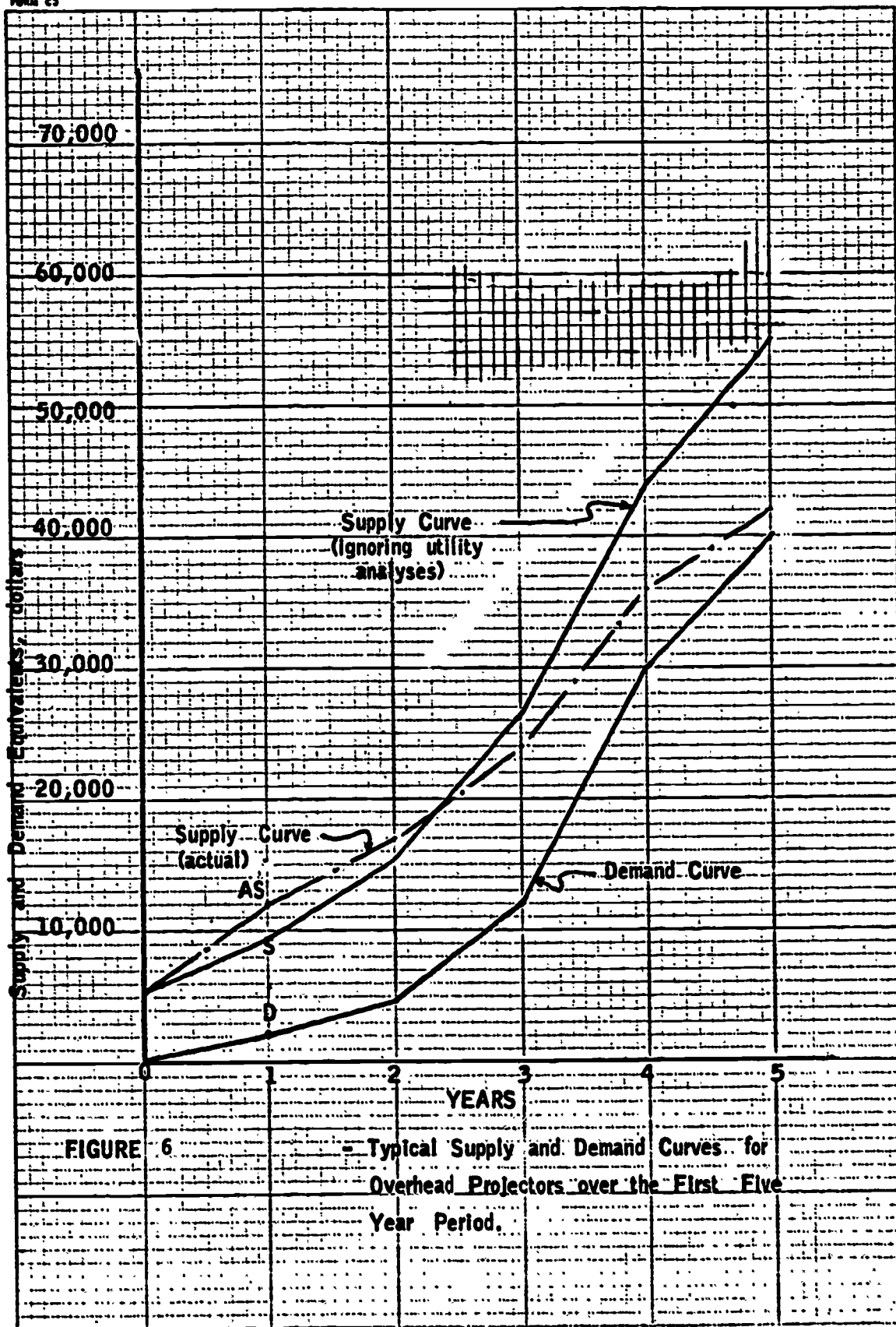


FIGURE 6

Typical Supply and Demand Curves for Overhead Projectors over the First Five Year Period.

BROWN'S BOOK SHOP, INC.
STATE ST. 1400
MADISON 5, WISCONSIN

TABLE 13 ALTERNATIVE DECISION RULES FOR ALLOCATIONS OF RESOURCES
GIVEN A SUBOPTIMAL BUDGET

DECISION RULES	ADVANTAGES	DISADVANTAGES
<p>Purchase all the items in the "desired budget" starting with the item having the highest utility and proceeding downward until the "allocated budget" has been spent. Items still lower on the list are not purchased at all.</p>	<ol style="list-style-type: none"> 1. Easy rule to implement. 2. All items that are purchased may be expected to operate at the desired level of availability and effectiveness. 3. By not purchasing items in insufficient quantities, we avoid frustration which may discourage future use. 	<ol style="list-style-type: none"> 1. By not purchasing certain items, we preclude the possibility of a well-rounded audio-visual program.
<p>Spend as much on the most important item as shown in the "desired budget" and spend less on less important items proportional to their utility ratings. Do this subject to two constraints:</p> <ol style="list-style-type: none"> 1. The sum of all the allocations must equal the "allocated budget". 2. Do not cut the allocation to any alternative system (item) below the point of minimum effectiveness. 	<ol style="list-style-type: none"> 1. This decision rule allocates resources mainly to those items which are expected to offer the greatest utility (value) to the institution. 2. The rule makes every desired piece of equipment available even under limited budgetary conditions. 	<p>148</p> <ol style="list-style-type: none"> 1. This rule is difficult to implement. It requires some complicated mathematical solution techniques or a rather tedious "trial and error" analysis. 2. When an A-V program is just starting up, there is little experience available regarding minimum effective levels for given pieces of equipment within the educational institution. Therefore, it is difficult to apply the second constraint.
<p>Decrease the allocation for each item by the same percentage as the "desired" budget was decreased.</p>	<ol style="list-style-type: none"> 1. Relatively simple rule to implement and perhaps the most obvious one. 	<ol style="list-style-type: none"> 1. By decreasing allocations uniformly, we jeopardize the effectiveness of all items and hence, the entire A-V program.

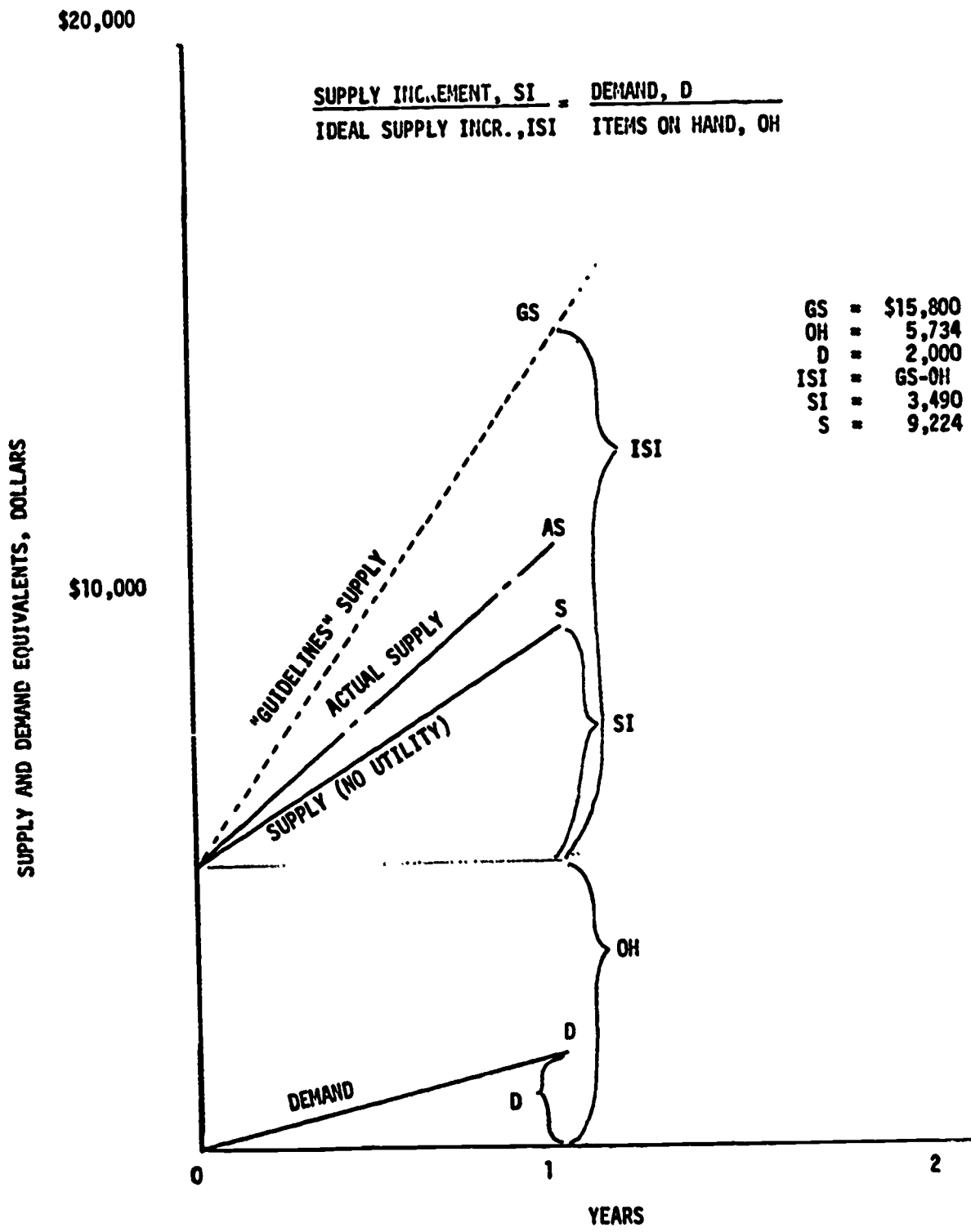


FIGURE 7 - Enlargement of a small section of the curves shown in Figure 17

we show how allocations are apportioned in succeeding years for one particular piece of equipment. The graphical presentation takes into account changes in the demand as well as utility considerations.

Continuous Budgeting and Allocation Over Time

The process of systematic budgeting over a period of time implies that national guidelines, the demand or usage of the equipment, and a utility analysis, are taken into consideration. The methodology proposed here becomes easier to understand if we consider the process of supplying just one item. Let us assume that we will plan and allocate resources for overhead projectors over a period of the first five years. As shown in Table 12 we have allocated \$5734 for overhead projectors in our initial allocation. No matter what our budget will be five years from now, we can estimate the percentage of that total budget which we wish to devote to overhead projectors. This can be done by utilizing the "advanced" national guidelines that are shown in Table 8. The "advanced" guidelines suggest that we should have one overhead Projector for every teaching station. This is an ideal objective based upon experience in hundreds of schools across the country over a period of at least twenty years. Although the characteristics of the institution under consideration may differ considerably from the national average, we are not in a position to know this from the outset and therefore, the initial use of such guidelines is suggested. We can also make a projection

regarding the number of teaching stations that will be available at the end of five years. We thus find the total number of projectors that will be needed five years from now and hence the necessary budget. If desired, the problem of compensating for the changing value of the dollar as well as unforeseen changes in the institution's building program may be bypassed by converting all of the dollar budgets into percentages.

We now have two points on an ideal graph: the actual initial allocation at time zero and the projected guidelines objective five years hence. A straight line connecting the two points as shown in Figure 6 yields an initial estimate of the ideal amount of money to be allocated to overhead projectors after the first year of operations (see Figure 7).

If, by the end of the first year, the demand for overhead projectors is equal to the amount on hand, then we would purchase the amount dictated by our projection. However, in the unlikely event that there is no demand for the equipment during the first year, then we would not purchase any additional equipment and we would remain with the initial amount on hand. The difference between these two amounts may be called the "ideal supply increment", ISI. The number of overhead projectors on-hand during the first year of operation may be converted into dollar amounts which are labeled OH, the amounts "on hand". The actual demand for overhead projectors may be called D. To find out how many additional

projectors we should purchase at the end of the first year, we make the supply proportional to the demand. Thus,

$$\frac{\text{Supply Increment, SI}}{\text{Ideal Supply Increment, ISI}} = \frac{\text{Demand, D}}{\text{Items on Hand, OH}} \quad (20)$$

Therefore, the supply increment is,

$$SI = \frac{(ISI)(D)}{(OH)} \quad (21)$$

As shown in Figure 18, the supply increment becomes,

$$SI = \frac{(15,800 - 5,734)}{5,734} \times (2000) = 3,490$$

Finally, dollar value of the total number of overhead projectors which are supplied by the end of the first year is equal to the amount that was on hand plus the supply increment. Therefore:

$$S = OH + SI = 5,734 + 3,490 = 9,224 \quad (22)$$

By means of the foregoing procedure, we can generate an ideal supply curve for each succeeding year. This supply curve takes into account the general guideline objective and the actual demand. However, if we pursued the supply policy represented by this curve, we would be ignoring the experience that we gain regarding the characteristics of the institution (other than actual demand), its educational program, and the actual audio-visual equipment that is in use. But most importantly we would be ignoring the goals and objectives of the institution and of the audio-visual department if we were to carry out the aforementioned

purchasing policy. It is possible to take advantage of cumulative experiences as well as goals and objectives, and the utility relationships by performing a utility analysis every year. In a manner identical to the one shown in Table 12, we can modify the ideal supply curve by means of the utility scores to obtain a more realistic supply curve shown in Figure 6. Each year the actual supply (AS) point of the previous year may be projected to provide an ideal supply point (S). The (S) point value may be weighted by means of the utility score assigned for that year thus yielding a new actual supply point, (AS).

As can be seen in Figure 6, the actual supply curve will converge toward the demand curve as time goes by in part due to the feedback between the system and its evaluators, the actual demand will be influenced by the actual supply. This means that if a given item is kept in very short supply and is not readily available when it is needed, then the demand will tend to fall off. This may be exactly what is desired in the case of a piece of equipment which is considered to have a low utility rating.

It should be noted that the actual supply curve for each piece of equipment is influenced by the constraint that the sum of all expenditures must be equal to the budget authorized for that particular year. The utility analysis will automatically help to apportion resources to those items which will do the most good and to decrease the supply to those

that are less useful. At any instant in time, we will be aware of the priorities that should be assigned to any given item. By conscientiously applying the utility approach in our allocation procedures, we in effect, actualize our desires. Another major advantage of this approach is that it provides a clear justification for increasing or decreasing a total budget or the allocations to any given item within the budget. It is also possible to introduce new alternative items of equipment for consideration at any instant in time, and to systematically allow such items to compete with existing item types for their respective share of the budget.

Conclusion

Although the methods and examples presented here have emphasized evaluation for the purpose of resource allocation, many other types of problems may be solved utilizing this approach. It is possible to rationally evaluate proposals for new curricula, facilities, research projects, student organizations, laboratory equipment, and so forth. The successful application of the foregoing evaluation methodology is contingent upon the ability and willingness of people to make explicit statements regarding their long-range goals, short-term objectives, evaluative criteria, and utility relationships. These are prerequisites for the processes of synthesis, analysis, evaluation and decision-making.

APPENDIX I

The LaGrange Method Applied to the Resource Allocation Problem*

We proceed to maximize the relevance of equation (15) subject to the constraining equations (12), (13) and (14). First, we differentiate equations (15), (12), (13) and (14) with respect to p_j , set the results equal to zero, and obtain in corresponding order

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$$\sum_j \frac{\partial R_j}{\partial p_j} dp_j = \sum_j r_j dp_j = 0 \quad (23)$$

$$\sum_j dp_j = 0 \quad (24)$$

$$\sum_j g_j dp_j = 0 \quad (25)$$

$$\sum_j a_j dp_j = 0 \quad (26)$$

Multiplying both sides of equation (24) by the thus far undetermined Lagrangian multiplier $-\lambda_0$; of equation (25) by λ_g ; of equation (26) by λ_a ; and combining we get

$$\sum_j (r_j - \lambda_0 + \lambda_g g_j + \lambda_a a_j) dp_j = 0 \quad (27)$$

However, according to the chosen maximization methodology, the quantity in the parenthesis must be zero as not all dp_j 's are zero. Thus

$$r_j - \lambda_0 + \lambda_g g_j + \lambda_a a_j = 0 \quad (28)$$

Substituting into equation (28) the statement of equation (8) and solving for p_j , we get

$$p_j = 1 + (1-p_j^0)[- \lambda_0 + \lambda_g g_j + \lambda_a a_j] \quad (29)$$

which according to (12) becomes

$$\sum_j \left(1 + (1-p_j^0) [- \lambda_0 + \lambda_g g_j + \lambda_a a_j] \right) = 1 \quad (30)$$

By adding $\sum p_j^0$ to both sides of (30) and rearranging, we obtain

$$\lambda_0 = \frac{-1 + \sum p_j^0 + \sum_j (1-p_j^0) + \lambda_g \sum_j \epsilon_j (1-p_j^0) + \lambda_a \sum_j a_j (1-p_j^0)}{\sum_j (1-p_j^0)} \quad (31)$$

or

$$\lambda_0 = \frac{(1 - \sum_j p_j^0)}{\sum_j (1-p_j^0)} + \frac{\lambda_g \sum_j \epsilon_j (1-p_j^0)}{\sum_j (1-p_j^0)} + \frac{\lambda_a \sum_j a_j (1-p_j^0)}{\sum_j (1-p_j^0)} \quad (32)$$

In order to shorten future notation let us define:

$$c_r \equiv 1 - \sum_j p_j^0 \quad (33)$$

$$c_g \equiv \sum_j \epsilon_j (1-p_j^0) \quad (34)$$

$$c_a \equiv \sum_j a_j (1-p_j^0) \quad (35)$$

$$c_n \equiv \sum_j (1-p_j^0) \quad (36)$$

Thus equation (32) can be restated as follows

$$\lambda_0 = 1 - \frac{c_r}{c_n} + \frac{c_g}{c_n} \lambda_g + \frac{c_a}{c_n} \lambda_a \quad (37)$$

which along with (28) and (8) becomes

$$\frac{1-p_j}{1-p_j^0} - \left[1 - \frac{c_r}{c_n} + \frac{c_g}{c_n} \lambda_g + \frac{c_a}{c_n} \lambda_a \right] + \epsilon_j \lambda_g + a_j \lambda_a = 0$$

or

$$\frac{1-p_j}{1-p_j^0} = 1 - \frac{c_r}{c_n} + \left(\frac{c_g}{c_n} - \epsilon_j \right) \lambda_g + \left(\frac{c_a}{c_n} - a_j \right) \lambda_a \quad (38)$$

Now if we know or can mutually agree, in a specific application, the absolute values of $\langle g \rangle$ and $\langle a \rangle$ then we can in a conventional LaGrangian fashion evaluate the λ 's and solve for the desired p_j 's. But, in practice, it would be difficult to establish such absolute values and so we must look for more conditional equations which will allow us to eliminate the λ 's. Fortunately these are not too difficult to establish for while we seldom can establish the total absolute value of any factor such as $\langle g \rangle$ or $\langle a \rangle$ we often do not lack an appreciation of their relative worths.

Condition #1

When a project, department, and so on has nothing to contribute to either generality (Interdependence-Outputs) or Articulation (Interdependence-Inputs) i.e., when

$$g_j = a_j = 0 \quad (39)$$

it appears logical to require that for such a category p_j should have no greater than p_j^0 . Inserting the condition

$$p_j = p_j^0 \text{ for } g_j = a_j = 0 \quad (40)$$

in equation (38) we get

$$\lambda_g C_g + \lambda_a C_a = C_r \quad (41)$$

whereupon on using equation (41) in equation (38) for any g_j and a_j

different from zero

$$\frac{1 - p_j}{1 - p_j^0} = 1 - \lambda_g g_j - \lambda_a a_j \quad (42)$$

The coefficients λ_g and λ_a are subject to the condition, equation (41). It will be more convenient to assign to them relative weights β_g and β_a such that

$$\begin{aligned} \beta_g &= \lambda_g C_g / C_r = \lambda_g \frac{(\sum g_j - \sum g_j P_j^0)}{C_r} \\ \beta_a &= \lambda_a C_a / C_r = \lambda_a \frac{(\sum a_j - \sum a_j P_j^0)}{C_r} \end{aligned} \quad (43)$$

Dividing equation (41) by C_r and substituting equations (43) yields the fact that

$$\beta_g + \beta_a = 1 \quad (44)$$

Insertion of equations (43) in equation (42) eliminates λ_g and λ_a thus yielding the formula

$$\frac{1 - p_j}{1 - p_j^0} = 1 - C_r \left(\frac{\beta_g g_j}{C_g} + \frac{\beta_a a_j}{C_a} \right) \quad (45)$$

This formula can be generalized in an obvious way to include other criteria as well.

Condition #2

In practical applications the weight β_g assigned to Generality (Interdependence-outputs) is likely to be greater than the weight β_a

assigned to Articulation (Interdependence-inputs). If we assign some general weight factor n such that

$$\frac{\beta_g}{\beta_a} = \frac{n}{1} \quad (46)$$

then

$$\lambda_g = n \lambda_a \frac{C_a}{C_g} \quad (47)$$

from equations (46) and (43). Substituting equation (47) into (44) yields

$$1 = n \lambda_a \frac{C_a}{C_r} + \lambda_a \frac{C_a}{C_r} \quad (48)$$

or

$$\lambda_a = \frac{1}{n+1} \frac{C_r}{C_a}$$

and

$$\lambda_g = \frac{n}{n+1} \frac{C_r}{C_g} \quad (49)$$

Equations (48) and (49) with (42) yield

$$\begin{aligned} \frac{1 - p_j}{1 - p_j^0} &= 1 - g_j \frac{n}{n+1} \frac{C_r}{C_g} - a_j \frac{1}{n+1} \frac{C_r}{C_a} \quad (50) \\ &= 1 - \frac{C_r}{n+1} \left[\frac{ng_j}{C_g} + \frac{a_j}{C_a} \right] \end{aligned}$$

The incremental allocation of resources of project j over and above the "must" items results in Equation (16).

$$\Delta p_j \equiv p_j - p_j^o = (1 - p_j^o) \left(1 - \sum_j p_j^o \right) \frac{1}{n+1} \left[\frac{\epsilon_j^n}{\sum_j \epsilon_j - \sum_j \epsilon_j p_j^o} + \frac{a_j}{\sum_j a_j + \sum_j e_j p_j^o} \right] \quad (16)$$

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PPBS : Challenge to Educational Planners

Richard H. Goodman

Introduction

The challenge educational planners face today is how to help our society solve the critical problems that relate directly or indirectly to public schools. Cities deteriorate faster than they are redeveloped. Rural blight, which our fathers fought, receives inadequate attention today. Suburbs are perhaps the most unreal places of all. Everywhere, the critics of education point out that schools are not doing the kind of job our society demands.

The fact that we recognize the problems of our society and their relationship to education means that educational planners have their biggest challenge yet.

Sir Thomas Browne, in the introduction to his book, Pseudodoxia Epidemica, published in 1646, wrote that knowledge is made by oblivion. His title, Pseudodoxia Epidemica, means "Epidemic of Half Truths." Think about this for a moment: "Knowledge is made by oblivion." Educational planners must be willing to put into oblivion any hypothesis used as a basis for their work, and replace it with a new one supported by new facts. PPBS can help us do this.

Good education does not just happen, nor is it limited to an 8:00 a.m. to 3:00 p.m., 180-day year. Good education will help each person achieve his optimum. It will permit him to

discover his abilities through a series of victories and defeats. In many ways, the process of education is like climbing a mountain or exploring space. Each win and loss leads to a new discovery.

Educational planners need to analyze the kind of "mix and match" of experiences which make the most sense for the education of any person. We need to analyze the systems that make up a school system.

A group of distinguished architects and artists, scientists and humanists, historians and poets, speaking at the Northwestern University centennial celebration in 1950, agreed that the major innovation of the 20th Century was relativity---the interrelationships in life. Educational planners must focus on the interrelationships in education and the PPBS concept can help to do this. Like marriage, PPBS is useless in a vacuum. It must relate to the world outside the school house.

What is PPBS?

Actually, there is very little that is new or revolutionary in the planning-programming-budgeting idea. The concepts underlying PPBS have been developed and examined by experts such as

Novick,¹ Smithies,² and Burkhead.³

Charles Rudiger, the Alfred Dexter Simpson NESCED Fellow at Harvard this past year and recently appointed assistant superintendent of schools for business at Westport, Connecticut, in a study⁴ for Harvard and NESCED, emphasized that:

"The planning-programming-budgeting systems concept combines the methods of established budget systems with some modern concepts and tools of management. It seeks to modernize the budgeting procedure by providing a link between the things that a school system buys (inputs) and the things it accomplishes (outputs). It presents a process by which complicated educational activities can be sorted out and analyzed.

¹David Novick, Efficiency and Economy in Government Through New Budgeting and Accounting Procedures, R-254 (Santa Monica, California: The RAND Corporation, February 1, 1954).

²Arthur Smithies, The Budgetary Process in the United States (New York, New York: The McGraw-Hill Book Company, Inc., 1955).

³Jesse Burkhead, Government Budgeting (New York, New York: John Wiley and Sons, Inc., 1965).

⁴Charles W. Rudiger, "The Applicability of the Planning-Programming-Budgeting System to Local School Budgeting," A Special Paper Submitted in Partial Fulfillment of the Requirements for the Degree Doctor of Education, Graduate School of Education, Harvard University (June, 1968) pp. ii-iii.

It involves the identification of educational and social goals and objectives; alternative ways to produce the desired results; for each of these, information on expected benefits, levels of effectiveness, penalties and costs over a multi-year period; the assumptions that have been made and that are associated with each alternative; and the likely effect of such alternatives on other programs and activities."

At the risk of boring you with definitions, permit me a moment to relate those used by the Bureau of the Budget in defining PPBS:⁵

"Planning: The study of objectives, of alternative ways of achieving objectives, of future environments, and of contingencies and how to respond to them. The purpose of planning (or analysis or evaluation) is to explore alternatives, to stimulate ideas about trade-offs and management strategies, to identify problems, to formulate theories, and to generate data.

⁵Murray L. Weidenbaum, Government Planning and Budgeting, Report No. 310 (January, 1967), Stanford Research Institute, Menlo Park, California, p. 2.

Programming: A method or system of describing activities according to objectives or 'outputs' and of relating these objectives to the costs in people as well as dollars or 'inputs' needed to produce the outputs.

Budgeting: The activity through which funds are requested....appropriated, apportioned, and accounted for."

The Bureau of the Budget states the following seven aims of the Planning-Programming-Budgeting System:⁶

1. "Make available to top management more concrete and specific data relevant to broad decisions.
2. Spell out more definitely the objectives of government programs.
3. Analyze systematically alternative government programs for meeting those objectives.
4. Evaluate thoroughly and compare the benefits and costs of programs.
5. Produce total rather than partial cost estimates of programs.
6. Present on a multiyear basis the prospective costs and accomplishments of programs, thus lengthening the time horizon of budget review.
7. Review objectives and conduct program analyses on a continuing year-round basis."

⁶Murray L. Weidenbaum, p. 3.

The planning-programming-budgeting system assists in the measurement, comparison, creation, and presentation of programs. The overriding purpose of the system is to provide a rational means of deciding how to allocate scarce resources among myriad, growing, and competing programs, needs and activities.

The uniqueness of PPBS, if any is to be found, is the interaction of planning with programming with budgeting. PPBS can bring focus to the process of education that a student is immersed in within a classroom, a building, a community. The system can help a principal and his staff make important decisions. Perhaps more important, PPBS brings decision-making power on the proper education of a youth to the specific school environment.

Financial Management Problems of Schools

Donald Rappaport, partner in Price Waterhouse and consultant to the Philadelphia school district, described nine major financial management problems facing schools in the Winter, 1967 issue of The Price Waterhouse Review:⁷

"1. In general, the school district administration

⁷Donald Rappaport, "New Approaches in Public Education," The Price Waterhouse Review (Winter, 1967 edition), pp. 6 - 8.

has little comprehensive knowledge of its operating or facilities requirements for the next five years. In any event, what knowledge it has has not been expressed in formal planning documents.

2. It usually has not established priorities and made decisions regarding fund requests on a systematic basis at any decision level below the chief administrative office, the Superintendent of Schools. Many times because of lack of information, even the Superintendent's decision making process is informal and priorities are established only by intuition.

3. Although annual appropriation and legislative requests are prepared 'realistically' in terms of the needs of the district, they are not 'realistic' in terms of possible revenue limitations. The result is often a drastic scaling down of requests to match revenues with consequent disappointment and wasted motion.

4. Appropriations are usually made by line-item object of expenditure, e.g., teacher salaries, textbooks, equipment, contracted maintenance. Consequently, (1) management choices during the year once the budget

is adopted are limited by the necessity to live within line-item constraints despite changed circumstances and (2) expenditures are seldom identified with specific programs of educational goals of the system.

5. The appropriation process and the attendant need to justify requests for additional revenues often lead to decisions in favor of programs easier to justify descriptively, e.g., those that are innovative---at the expense of closing gaps in administrative effectiveness that have equal but a less obvious effect on educational output.

6. Since immediate needs almost always far outstrip funds, management faces a major problem in carrying out longer-range, more permanent solutions versus the continuous showing up of operations through short range expediences.

7. School systems have no capability built in to deal with two major information problems facing the superintendent of schools and the Board of Education ---the hottest spot in town: one is the need to know quickly the answers to critical questions as they come up. Such questions are asked daily and directly

by the press, parents, children and civic groups. Two, the need to have complex information organized in a manner that simplifies decision-making.

8. Education does not have the advantage of the stern discipline of the profit and loss statement. This has led over the years by and large to the avoidance of measurement of what was being accomplished, especially in terms of how much it was costing. Furthermore, the educational establishment has traditionally resisted measurement attempts both on the grounds that educational output is too difficult to quantify and that such attempts would tend to distort educational objectives from their true qualitative goals. There are as a consequence only a few broad educational measurements in current use. Reading level is one. Using business profit and loss statement terms, public education doesn't know what its sales are. It has simply assumed that higher per pupil costs means more education (sales). On the cost side, overall comparative information among school districts appears to be the only measure now being used, a rough guide indeed.

The wide use of this kind of comparative cost analysis probably stems from the absence of other measures.

9. The question of responsibility, authority and accountability throughout the entire financial management structure of a typical big city district poses several very real difficulties. The basic question is the classical 'authority vs. responsibility.' Let us briefly sketch some of the administrative relationships. Starting at the top of the administrative structure with the chief administrative officer, we find that the superintendent lacks a most essential authority of a strong executive, the authority to allocate funds---a power that is almost always by law in the hands of the School Board. Thus, the superintendent's responsibility for the effective administrative operation of the district on this basis alone is shared with the Board of Education. Broad policies obviously and properly the province of the Board also require the Board to implement them by funding decisions."

Mr. Rappaport goes on to describe how PPBS is one approach that can help a school district overcome these problems.*

*See the Winter, 1967 issue of The Price Waterhouse Review for a detailed description of how this has been developed in the Philadelphia school system.

PPBS and State Aid to Education: A Look at New Hampshire

You will be interested in developments tied to the politics of education in the State of New Hampshire where there is a strong emphasis on home rule and which is my native state. With approximately 130,000 students in nearly 200 separate school districts, New Hampshire has no sales or income tax---the property owner is the chief supporter of schools. The interests of the citizens of the state are protected by the third largest legislative body in the English-speaking world---exceeded only by the United States Congress and the British Parliament. The 400 representatives and 24 senators are under pressure to adopt a broad base tax, since the sweepstakes is fizzling away. One of the Granite State's most respected politicians, Senator Stewart Lamprey, two months ago submitted the following report to the Fiscal Committee of the state legislature in response to a request for a more rational way of providing state aid to local school districts:

"Members of the Subcommittee agreed from the beginning that any such formula for state aid to education should provide financial encouragement for local school districts to adopt educational programs and methods which can be directly related to improved student performance.

"Accordingly, this Subcommittee set out to discover whether the cost of New Hampshire education can be directly related to the quality of education in this state.

"Early in our investigations, the State Department of Education suggested that the size of a school was an important factor in the determination of educational excellence.

"For this reason, we expanded the scope of our study to include variations in size as well as in per-pupil expenditure.

"...To summarize some of the more important results of our investigation:

1. Our findings show no evidence that increases in educational expenditures or in the size of schools will, in and of themselves, result in improved educational performance. The subcommittee, however, relied upon existing educational data in the development of this study, and found that available information is extremely limited.

2. For this reason, the Subcommittee recommends that the Department of Education develop and submit to the 1969 Legislature, a program for evaluating educational output so that

- it will be possible to identify and encourage those factors which will result in improved student performance;

- there will be an acceptable method of measuring the comparative effectiveness of alternative educational proposals and of evaluating the success of programs and methods already in operation;

- a rational program for state aid to education can be designed to encourage educational programs and methods which can be proved to be directly related to improved student performance.

3. The Subcommittee also wishes to recommend that future education proposals presented to the Legislature be accompanied by student benefit justification, and that these proposals contain provision for evaluating their effectiveness once they become operational.

"The Subcommittee wishes to make it clear that this report does not claim that cost and size are in fact unrelated to educational excellence---only that we have been unable to prove any such relationships on the basis of available data."

"We do wish to emphasize the importance of identifying factors which can be shown to be directly related to improved student performance. Further analysis along these lines will be most helpful to the Legislature, local school districts, New Hampshire's taxpayers and, most important of all, New Hampshire's students."

Senator Lamprey obviously intends to apply a portion of the PPBS concept as a basis for appropriating and distributing state aid in the future. The emphasis will be on developing criteria for measuring and evaluating the effectiveness of school programs.

A problem in this approach is that most evaluations conducted by teachers, administrators and boards of education utilize standardized tests, checklists such as the Evaluative Criteria, and subjective instruments such as, "Profiles in Excellence---Recommended Criteria for Evaluating the Quality of a Good School System," published by the NEA.

PPBS: A Key to Interrelationships of Education

The challenge before educational planners is to apply PPBS concepts in a way that will help schools focus on the interrelationships, over time, of the inputs to the education of a youth ---inputs both in and out of the classroom. We must go beyond the traditional approach of analyzing and planning the educational system as it exists today with the narrow focus on the curriculum that teachers and administrators do not interrelate, but simply provide books within each subject and classrooms to separate whatever relativity might be discovered in the curriculum.

A key to the planning-programming-budgeting system is developing and analyzing, in a systematic way, alternative means to achieving predetermined ends. For example, a major objective of the school is for children to learn how to write. (When one reads some of the papers written by educators, from which I would not exclude myself as one, one wonders where our system failed.) Applying PPBS techniques, educational planners would observe there is no "system" for teaching writing, but a series of unrelated approaches.

NESDEC has sponsored a study of the teaching of writing by a Pulitzer-prize winning professional writer, Don Murray, these past three years. Called "Project Write," this brought together

18 experienced English teachers from throughout the six New England states and has resulted in a book published last month by Houghton-Mifflin Company, A Writer Teaches Writing. The book is packed with ideas on how to teach writing. But how will it find its way into a school system that is not a system at all but a collection of separate kingdoms?

When we look at broad social problems which the schools must help solve, particularly our racial crisis and the increase in crime, the need to develop a more rational approach in education is evident.

PPBS in the Schoolhouse

Rudiger emphasizes the role of the building principal in working toward such ends, under policies set and encouraged by the board of education and advanced by the central office administration under the leadership of the superintendent of schools. He states that:⁸

"....An autonomous building principal should have the human and material resources at his command to initiate remedial programs, based on needs determined in his building. The employment of specialists,

⁸Charles W. Rudiger, pp. 31-32, 37.

para-professionals, or aides; alteration of class size, purchase of special 'high interest-low vocabulary' reading materials, encouragement of parent and community involvement, are all important considerations and possibilities....But the operation of such a program at the building level to any significant extent is limited to short-term endeavors. The tendency toward institutionalization of programs and procedures, need and demand for more sophisticated teaching materials and equipment, the lack of appropriate analytical capability, and the effect of varied class size and teaching load on other aspects of the local school program, all tend to militate strongly against planning, programming, and budgeting of long-term programs at the local building level of operation."

"....Important choices and decisions....are quite often made on the basis of empirical judgments by apparent experts, through some form of political advisory process, by compromise in committee, or by administrative fiat. In any of the above cases, assuming positive intent and motivation, decisions may depend largely on judgment and intuition. So must the advice derived from systematic

analyses.⁹ But the real worth of such analysis is that it permits judgment and intuition of people from various places and levels in the educational system to be combined and synthesized systematically and efficiently...."

Conclusion

If PPBS is to serve education, educational planners must use it to create an understanding of the interrelationships among the curricula in the schools, and between the school and non-school life of a person.

Archibald MacLeish, in an article called "The Great American Frustration," published in the Saturday Review two weeks ago, wrote:

"Is it our education, then, which has shaped the very different estimate of man we live by? In part, I think; in considerable part. Education, particularly higher Education, has altered its relation to the idea of man in fundamental ways since Adam's day and Jefferson's. From the time when Harvard President Charles Eliot introduced the elective

⁹E. S. Quade, Systems Analysis Techniques for Planning-Programming-Budgeting, P-3322 (Santa Monica, California: The RAND Corporation, March, 1966), p. 5.

system there - from the time, that is to say, of the renunciation by the university of an intention to produce a certain kind of man, a man shaped by certain models, certain texts---the university's concern with 'man' as such has grown less and less and its concern with what it calls 'subjects' has become greater and greater. The important thing has become the academic 'offering' (revealing word): the range of subjects from which the student, with his eye on his career, may choose. And the ultimate consequence, only too evident in the time we live in, has been the vocationalization of the higher schools. The college no longer exists to produce men qua men, men prepared for life in a society of men, but men as specialized experts, men prepared for employment in an industry or a profession."

Educational planners must help the school and other community leaders focus on the what, where, and how of the many inputs that can be brought together in the education of a person. By focusing on such interrelationships, we can bring about comprehensive planning that dares to look beyond the next two or three years. It will be tragic if we simply use PPBS to solidify our present educational system. The challenge before us is to use this tool

to bring about a total school system that will combine the many facets of life in a way that will help each of us become a more complete person able to create a better society.

Part Two

Long - Range Planning in Public Education

Program Budgeting in Education : Some Organizational Implications

Marvin Hoffenberg

Program Budgeting

Program budgeting is an attempt to rationalize - in the economist's meaning of the term - the decision process in the management of public non-market systems. Local education is one such system. Over the past two decades a number of analytical approaches have been developed, and further refinement of older techniques has been carried on for this purpose. Whether these are called operations analysis, cost-effectiveness analysis, systems analysis, or benefit-cost analysis, they all represent efforts to systematize the calculation of gains and losses associated with specific choices under varying degrees of uncertainty.

The meaning of program budgeting is often in the eye of the beholder. The basic interpretation used here is as an informational environment; the definition is given in Table 1. For operational purposes, program budgeting is a system management process covering planning, programming, and budgeting. Planning and programming are different aspects of the same process. Planning stresses the choice of future actions through a systematic evaluation of alternatives. Programming stresses the specifics of resource use - manpower, supplies, and capital equipment - required for implementing a program after it is selected. In addition, except in the very "short run" where dollars are in effect "a given," programming involves concern about financial requirements (Budgeting) for programmatic implementation.

Why the current drive for changes in conventional budgeting and a movement towards a program budgeting process for education? More and more throughout government and industry the budgeting process is conceived as a guide for policy decisions and as an instrument for effective management. But conventional education budgets are developed mainly for the cost accountant and the comptroller; they are not designed as a decision-making and management tool.

The common format in the typical current conventional budget in education covers seven categories: general control, instruction, maintenance of plant, operation of plant, fixed charges, auxiliary agencies, and minor capital outlays. These are input items and are not related to output. Educators talk mostly about input: "What do you pay teachers these days?" This input oriented--line item--budgeting process tends to ignore long-range planning; it stresses details of personnel and organization rather than the functions of developing and managing educational goals. In brief, current budgetary practices fail as an effective device for educational system operations and management.

The program budget format, however, is structured to organize cost data by programs which, in turn, are presumably related to objectives and to outputs. (The latter, hopefully, are measurable.) As useful as the program budget format may be, just as format, its design must be related to the other aspects shown in Table 1, the analytical and control processes. What this means is that the aggregations used should permit meaningful trade-offs on the output side, and perhaps some organizational cross-classifications for control purposes.

TABLE 1*

THE PROGRAM BUDGETING PROCESS

- A. Structural Aspects: The program budget - a format(s) for structuring and organizing funding information.
1. Cost data are summarized by programs, sub-programs, etc. that:
 - a. Can be related to specific outputs and objectives which are at least partially quantified.
 - b. Are clearly delineated, and, insofar as feasible, are self-contained, and, which group together components that are in close competition with each other.
 - c. Are broken down into operationally useful building blocks (manpower, material, facilities, etc.).
 2. Contains funding and expenditure information including noncost data such as transfer payments.
 3. Covers an extended time horizon, e.g., contains data for as long as five years into the future. In order to eliminate possible discontinuities program costs may have to be extended beyond the terminal date shown.
- B. Analytical Aspects: Involves use of analytical tools in systematically examining alternative policies and programs and their implications.
1. Example of one such tool: benefit-cost analysis, which uses cost information appearing in the program budget plus additional data such as indirect costs, benefits, spillovers, etc.
 2. Analysis also includes consideration of both statistical and real world uncertainties and their implications for planning, programming, and budgeting.
 3. Objectives are constantly reviewed and alternative ways of achieving them are formulated.
- C. Administrative-Organizational Aspects: Provides a basis for administering, enforcing, and revising allocative decisions. Also includes the basic information system(s) for analysis and implementation.
1. A continually updated plan and financial program.
 2. Year-round decision making on new programs and changes in old, approved programs.
 3. Progress reporting to test the validity and administration of the approved programs; a feedback operation.
 4. Adequate provision of informational requirements for all aspects of program budgeting.

*Adapted with minor modifications from, Hirsch, W. Z. Program Budgeting For Education (Los Angeles: University of California, Institute of Government and Public Affairs, 1966), MR-63, p. 6.

Strong pressures for developing program budgets in education come from state governments and from the U.S. Office of Education through intergovernmental fiscal relationships. The Federal government already has a program budgeting system; state governments are developing them. As the higher levels of government use the system they will need more and more to secure necessary information and results from local levels in order to properly evaluate their own resource allocations for aids and grants. In addition, granting institutions increasingly require evaluation as a precondition for future grants and are stressing the research and development process in primary and secondary education. All this puts pressure on local school districts to develop elements of a program budget. As a matter of fact, one use of the program budget that is most likely to develop is in the "adverse game" (bargaining) among the three levels of government.

As more and more subnational units adopt program budgeting we will probably find a development towards mutually compatible sets of program structures. National and state financial aids to local schools are crucial pressures since the question of whether or not action follows policy has to be determined. Something analogous to the U.S. Budget Bureau's Standard Industrial Classification for programs in education will be developed. There is a growing need for a common language here.

Allen Schick [7] summed up the differences in the federal budgeting process before and after the introduction of the federal program budget

as follows:

"All the differences may be summed up in the statement that the ethos of budgeting will shift from justification to analysis. To a far greater extent than heretofore, budget decisions will be influenced by explicit statements of objectives and by a formal weighing of the costs and benefits of alternatives." (p. 258)

This quotation would also apply to local school planning-programming-budgeting systems. The core of the new budgeting folklore, then, is alternatives and the convergence of planning and budgeting. Also, as outlined in Table 1; the process has a built-in feedback loop through periodic review and evaluation. In the future, appeals to tradition, authority, and custom will be less acceptable.

To this point program budgeting has been presented in the conventional manner, as a system management process for rational decision making and system control. In this vein, program budgeting is influenced by two recent trends in the application of the behavioral and social sciences to policy analysis and system management. First, an increasing effort towards rationalizing the decision process in both the public and private sectors; and second, the institutionalization in large complex organizations of the search for problem areas and for alternative means to handle them.

In government, as noted above, there is the developing federal program budgeting system as well as the Department of Defense's cost-effectiveness approach to the analysis of military problems and their trickling down to subnational political units. In industry, it is now commonplace to choose corporate objectives through a systematic search for alternatives and to implement plans based on maximizing the

opportunity of goals attainment at least cost and risk. That complex questions such as governmental budgeting and corporate strategy can be attacked through rational processes of analysis no longer seems to be in question.

There is a difference, however, between an attack on a problem and a solution to a problem; between a conceptual and methodological framework and procedures and implementation. Social, and this includes educational, problems are rarely "solved" it depends on the definition of "solved." More commonly, they are transformed and subdivided into more tractable problems. Questions concerning the role and feasibility of rational methodologies subsumed in program budgeting, turn in part, on the nature of problem areas and the institutional environment.

In a perfectly rational world, with perfect information, planning and programming for local primary and secondary schools would be constructed in the following way: The process begins with a statement of precise, operational goals. A model of the education system is constructed; this may be in the form of mathematical equations, a game in which the rules constraining the actions of the players simulate real life, or a computer program. Whatever its form, the model serves the purpose of making explicit the assumed relationships between interacting elements of the system under study. The model is used to compare the effects of alternative courses of action or in-action; in terms of their costs and benefits. Costs, of course, are more than money; they

include, in concept, the expenditure of all resources which might otherwise have been available for other uses. Benefits, when commensurable, resulting from the alternative course of action would be weighed one against the other; those which would closely approximate the goals with least cost would presumably be the most desirable. Least cost in this example is the criterion for choice but other decision rules could be used. This process is a description of system analysis. (Some individuals tend to confuse systems analysis with program budgeting; these are not identical.)

The process is easily described but may be immensely difficult to implement, particularly in an open, complex school system. As we look at the possibilities of application in today's and tomorrow's educational worlds, the vigor and specificity of the process disappears. Systems specifications become looser, performance characteristics more ambiguous, decision rules more controversial, objectives multi-valued, and goals elusive. The educational world is not perfectly known or specified, there are many uncertainties especially about means and ends, and the future is opaque, not crystal clear.

But no one should look at the program budgeting process as a cure-all. Such methodologies as cost-effectiveness, system analysis, etc., at best are organized methods for conceptualizing multi-dimensional problems and selecting more objectively among open alternatives. They are no better than their simulations, no better than the ingenuity of their designers who must after all invent the alternatives to be tested.

Incorrect models, unrealistic boundaries, ill conceived alternatives, false objectives, can lead to choices which may be worse than picking at random. All that is implied here is, don't expect a panacea and don't unwittingly use rationalizing methodologies as "gimmicks." The latter is pertinent for those construing program budgeting as just another application of cost-utility analysis. More to the point, is the delineation of possible contributions and some feel for the limitations as the process is applied to local schools. These are the subjects of the balance of this paper.

Program budgeting will provide a new and improved informational environment for managing and controlling a school system; for monitoring and evaluating its current state as well as guiding it toward a future set of states. This informational environment must be placed into an institutional framework since it is within the school system that it will function. In so doing it is also necessary to look at the "system" and the pressures upon it.

Aspects of School Systems

Schooling is increasingly a matter of total social concern and more and more a point of social intervention by governments. For example, the value placed on education by minority groups, by suburbanites, and the preemption of significant shares of local tax revenues, makes the school system a focal point of community interest, participation, and increasingly of social conflict. Schools can be effective change agents.

The schoolhouse is no longer a relatively closed system of concern only to its students, teachers, and parents. The educational system is under siege, at least in large urban places, for increasing openness, for more neighborhood control, for community pressures on school structures, and on instructional processes, content, and possible outcomes. The local schools are one, of a few institutions, where latent community conflicts - of race, or religion, and of social class - can come into force. Just note the demands for courses on the history and role of Blacks in America, the emphasis on including Mexican culture in the curriculum, the demands for minority group teachers and administrators, and not least, the demand for Mexican food in Los Angeles City school cafeterias.

More precisely, schools are open systems. Open systems constantly interact with their environment and with continual inputs and outputs, with dynamic functions and changing states. Such systems may not be self-regulating and direct intervention at various decision points may be necessary to regulate the system and keep it within tolerable bounds. Today, with student strikes and "blow-outs," with parental civil disobedience and teacher strikes, there is an apparent tendency for some schools to go beyond bands of tolerance and direct intervention through use of public power is required.

To speak of uses of public power to regulate a system means that

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we are designating a political system [9]. The distinguishing characteristic of a political system is the attempt by society to regulate a set(s) of relationships through the exercise of public power. This is contrary to American local public school ideology which dictates that partisanship has no place in managing the school system. Nevertheless, it is more and more obvious that it is in the management of the local school that the educational process and the process of community politics converge. The focal point where external pressures show up most consistently is the school budget. Consequently, program budgeting provides a new informational environment for generating and resolving this convergence.

Who controls, and who regulates, and for whom should program budgeting be developed? A corollary question is who controls the controllers?

Neal Gross [2] found in his research that the most determining factor in the local educational structure is the school board. The board, for example, is crucial in determining the extent to which environmental pressure groups influence the schools. The management of the school system involves regulating two sets of relationships. One the internal relationships and the other the relationship between the school and its environmental matrix. The board then seems to be the point for regulating and manipulating these relationships. Consequently, the design of a program budgeting system should be dominated by how it is used by the school board.

School boards have their own relationships - both internal and external - and operate under constraints. Examples of this are not hard to find. Some superintendents, although only executive officers of the board, so dominate that they are, in effect, decision-makers. One of the major sources of pressures on school boards, particularly in big districts, is the classroom teachers and teacher associations. Collective bargaining and strikes are accepted these days.

The formal organization structure of the school system is designed to permit local control. Each system is locally based so that a citizen can reach the superintendent and the school board. As a matter of fact, one of the few chances a citizen has these days to exert his influence directly on an important public system is in the schools. This opportunity is being seized on an increasing scale. Other important external pressures come from legislatures, from State departments of education, and from the U.S. Office of Education. All these groups will also want information from a program budgeting system.

This then, is the model I will use, an open system, regulated by a board, with the budgeting process as the guts of the regulatory system.

Organizational Behavior

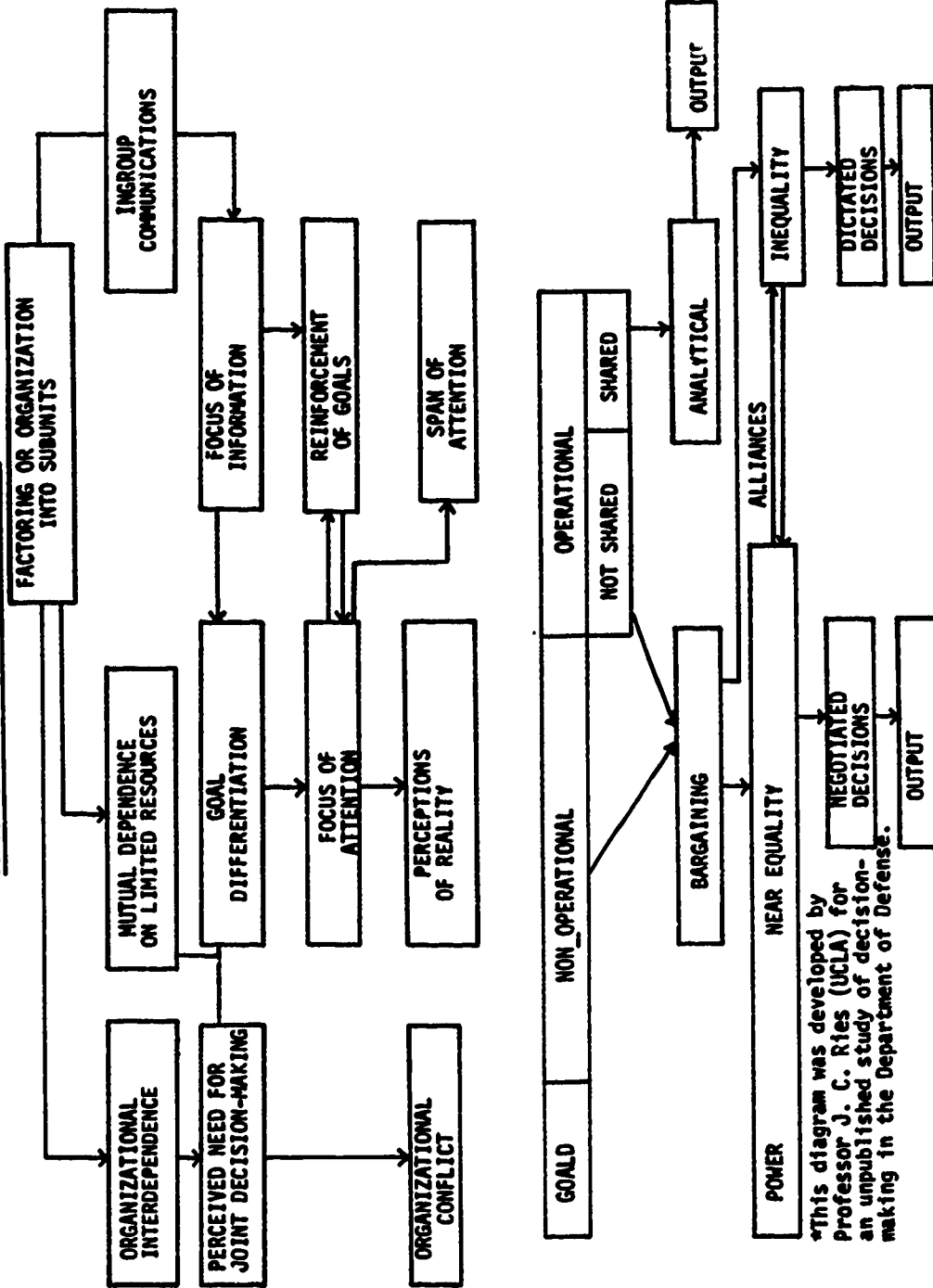
The model, as formulated, requires that program budgeting be appraised within a large, complex, and open system as another element in organizational decision-making. Since what actually occurs is organizational decision-

making it is not simply a question of how the few should choose for the many and the generation of decision rules for individuals acting as individuals.

A significant problem in applying program budgeting to educational systems is how to appropriately blend the "rational" decision processes of designating relative merit with the behavioral processes of organizational decision-making. That is, how to blend "rational" and "extra-rational" decision processes. If all the members of the educational organization shared the same values, desired the same operational objectives, had complete information, if there were no uncertainties, if the school system were a closed one, and so forth, the two decision processes could yield similar choices. But such conditions do not exist. For example, organizations as organizations have no operational goals; their members do. In such cases where resources (including political power) are scarce, where organizational subunits (individuals) have different preference functions, exchange will take place. This leads to a definition of an organization as a coalition bargaining over side payments. A critical role for program-budgeting in such a situation is to aid in defining the meaningful boundaries for bargaining.

As yet, there is no general theory for organizational decision-making. Table 2 represents an attempt to portray the organizational decision process in local education. It is based largely on the work of March and Simon [6], and indicates the conceptual framework used here.

TABLE 2
SCHOOL SYSTEM DECISION-MAKING MODEL*



*This diagram was developed by Professor J. C. Ries (UCLA) for an unpublished study of decision-making in the Department of Defense.

The thesis that runs through Table 2 is that of fragmentation and conflict; the antithesis, that of organizational interdependence and the need for joint decision-making; and the synthesis, that of conflict resolution through bargaining or analysis. It portrays a classical bargaining situation where the ability of one unit to get what it wants is dependent upon the actions of others. In the diagram there is no distinction between internal and external systems. The reason is simple, any definition of a system or an organization is arbitrary; it all depends on what decision is being made.

Information is the basic ingredient for decision-making and management. The informational framework and the communication network used are critical overlays on the processes shown in Table 2. By information, I mean the basic bits of data (quantitative and qualitative) that enter the system; by communication, I mean the ways in which information is abstracted, aggregated, and the forms in which it is passed on. Communication is a many splendored thing, provided the elements of an organization have something to communicate about. An organization may be viewed for some purposes as composed of elements connected through a communication network. Change the flows, and the organization and control mechanisms change. This is why a new program budgeting informational system is likely to lead to some different decisions; presumably better ones.

The development of American public school systems is largely one of increasing specialization in subject matter and in the tasks of those engaged in transmitting knowledge. Accompanying instructional programs

has been many auxiliary activities such as counseling, testing and evaluation, and now, even program budgeting. This specialization belies the vision of a monolithic organization pursuing an agreed upon operational goal. The organization is increasingly fractured as the trend towards specialization continues and results in differentiated specific goals.

In-group communication systems are developed through a focus on selected information which, in turn, reinforces differential goals. There is no physical counterpart to a school system; the model of such a system is one of connected elements with no uniform specifications and performance characteristics, or agreed upon norms. Consequently, the focus of attention, stemming from differentiated communication systems and frames of reference, tends to build different models for the fragmented units. There are selective perceptions of reality (cognitive maps) resulting in models with differing characteristics and differing weights attached to common elements.

There are other trends which affect the cohesion of the local school system. One is the growing militancy of teacher associations as they attempt, and often succeed, in opening the system for their say in educational decision-making and in managing the schools. Trade union or professional association and employee bargaining in education differ from traditional collective bargaining. Not only are there negotiations over a given production function, (rates of inputs and rates of outputs), as well as working conditions; but, often as important, negotiations over what is produced and its quality as well as auxiliary services for students.

Historically, since the general community was outside the educational establishment and its supportive power structure, school boards and school administrators could concentrate on their own ways of keeping school. There is ample evidence that in recent years the educational management system and the educational establishment is under attack by external blocs. People just want entrance into, and participation in, system management.

The budgetary process is a mechanism for distributing things of value in the educational system--who gets what. Consequently, the budget is a key intervention point for the regulation of internal school relationships and the relationship of the formal educational system to its environment. Since scarcity is a fact of life in the educational world, the budget also indicates the mutual dependence of the organizational units on limited resources, which, in turn leads to conflicts. It is also a means for organizing such conflict.

In discussing program budgeting it is often said that it sharpens the intuition and judgment of decision makers. A corollary of this, is that it also sharpens issues and focuses conflicts. The latter worries some people, mainly academicians. But I believe that, in the minds of the worriers, too much is imputed to program budgeting and it becomes the proxy for many other social forces

leading to current and future dissension. Participatory democracy, in some form, is taken more seriously these days in regulating local schools.

The need for improved educational information systems in recent years has been made critical by the increases in scale, in complexity, and in the uncertainty about instrumental means in the school. Program budgeting in all its aspects is a new information system. Over time, it will change the communication system and permit new frames of reference (new cognitive maps) to be formulated. Unlike the current information system, it will permit a more general and consistent set of cognitive maps. It will be a force that can be used to improve the cohesiveness of the system. It will also change the structure of the system. We know little about the relationships between structure, process, and outcome other than we believe that there are causal links.

Constraints on the Uses of Program Budgeting

As a new information environment within which to manage schools we can, following Vickers [9], relate program budgeting to three of its stated objectives: to ensure that action follows policy; to improve the information on which to choose between one program and another; and, to guide the distribution of resources between one policy

area and another. In seeking answers to such questions the educational system model described above will be used.

The educational world is not perfectly know, there is uncertainty about means and ends, and about the future. Problem areas that dominate the application of program budgeting are: the lack of knowledge on how to measure output; the difficulty of setting operational goals; and, the many uncertainties faced by the school system.

Most educational measures are about input: per pupil cost of instruction, of operations, of maintenance; instructional personnel per pupil, and so on. There is a good reason for this; about output, we are fuzzy. The simple fact is that there is little consensus on what educational output is, or should be. One of the biggest obstacles in applying the theory of program budgeting in education is our inability to define output in operational form.

Does this fuzziness in handling output invalidate the claimed advantages of the program budget format in relating resource use to output?

Another important use of the program budget structure is that it reflects school board policies at each level of aggregation used. Resources are allocated to administrators to implement such policies. Referring back to C3 in Table 1, a validating and feedback operation

is built into the system through periodic progress reporting. To the system managers, the budget format and periodic progress reports serve as cues as to whether or not action has followed policy. They may also serve as similar cues to the local policies.

There is an important qualification to the program budget format as a means to relate action (resource use) to policy, namely, an educational activity or program may relate to more than one policy, (output). On a philosophical level, this multi-policy problem will remain as long as we consider education both an investment good and a consumption good. On a more mundane level we are often confounded by the distinction between an intermediate and a final good; and by joint products. For the former, there is the question of whether such activities as library services are inputs say into an English activity or ends in themselves. Similarly, at the elementary school level, where the prime objective is learning the three R's, other activities such as geography also provide instruction in reading, writing and arithmetic. For these reasons I have deliberately chosen the word cue, in commenting on ascertaining any relationship between action and policy.

To take literally the statement that goals are attributes of system elements and not of systems would invalidate overall planning and analysis.

There is an apparent answer to such a paradox, the perceived need for joint decision-making.* The organizational elements are both dependent and interdependent. For most organizations, survival is an agreed upon goal; there is less agreement on the activities required for viability. Since there is little general agreement on the goals of the educational process, and on educational output, agreed upon goals are necessarily non-operational; it is a bargaining situation.*

Policies for the future are among the side payments that organizational coalitions bargain over. What is likely to emerge is a general consensus on the future states of the system over time - the goals; about some things that will be done and about things that will not be done. Such states are purposely vague in order to obtain a consensus. Planning and the choice of alternatives on a general systemic level in education are, at least in our current stage of ignorance, necessarily tied to considerable vagueness in itself is a type of uncertainty that the organization must adapt to.

The program budgeting process tends to institutionalize planning and the search for alternatives. Here, again, is a seemingly paradoxical situation, a greater need for knowledge about the future at the same time the planning-programming-budgeting process identifies and creates more areas of uncertainty, and both nestled in an environment with increasing turbulence.

*See Table 2,

Historically, much of the technology of education was based on custom and authority; challenge and innovation were considered as heresies.

Today's educational technology rests on some assumptions about a production function involving relationships among instructors, pupils, teaching equipment and materials, and socioeconomic variables with some proxy for output. The form of the function and the coefficients assigned to the separate variables are still unresolved. Innovations - changes in the production function - were gaining momentum, even prior to the introduction of program budgeting. As a matter of fact it has become not only legitimate, but also fashionable to challenge the educational status quo. The pressures for innovation are increasing as well as are the number of specific innovations.

The Federal government through the establishment of regional research and development centers, through Title I projects, through poverty programs, and through other grant programs, is developing and will continue to develop, new instructional programs and new ways of keeping school. The very fact that research and development and program evaluations are emphasized creates an atmosphere conducive to innovation. The private sector also does its part in creating pressures for technological change; there is potentially a vast market in the educational field. Throughout, there is an increasing emphasis on hardware of various types, which should change capital-labor ratios. But an innovation is always the contender;

it competes with an existing way of how to do something. We may not know all about the present technology but we know some things about its good and bad features in actual application. The new technology needs some ex ante evaluation, and this, in turn, requires the development of new methodologies.

All of this increases the uncertainty in planning, and creates problems in the search for, and evaluation of, alternatives.

Planning and the evaluation of alternatives in program budgeting are problem and policy oriented. The analyst involved is more the applied scientist or technologist than the pure scientist, and requires what Olaf Helmer [3] and Gordon, Hoffenberg and Helmer [1] have described as social technology. The planner and analyst is less concerned with the detailed understanding of all the underlying phenomena and more with the effective control of his environment. However, like the exact scientist, the program budgeter tends to make use of conceptual models; but while in the case of the exact scientist such a model is apt to be part of a well-confirmed body of scientific knowledge, the program budget model is usually of a more tentative character. Even if the current status of knowledge provides no well-established theory for the phenomena to be dealt with, the analyst must nevertheless construct a model as best he can. In such cases both the structure of the model and its numerical inputs often have an ad hoc quality, representing merely the best insight and information which happen to be available. As further insights accrue

and more experimental data become available, the analyst has to be ready to discard his first model and replace it with an improved one. This tentative procedure, dictated by pragmatic considerations, is thus essentially one of successive approximation. This procedure clearly requires the use of intuition and some methodology for incorporating expert judgment. In other words, the methods used though systematic are by no means rigorous, and cannot be expected to be.

The above emphasis on an iterative process translates into an emphasis on the planning process, not on a plan. What is required is the building of a viable planning process that can integrate innovation and adequately react to uncertainties. In theory, this is what is involved in program budgeting, an iterative planning and evaluation process with feedback mechanisms. (See Table 1.) Much has been said about the extended time horizon of the program budget; the five year plan. All that this time stream is supposed to show are the future implications of current major decisions. In current program budgeting practices one knows that next year's decision will have different implications over time. Uncertainty is thus not eliminated - certain areas of uncertainty are identified.

Planning and the evaluation of alternatives in education have been mentioned without any discussion of how to choose between alternatives. Let us now turn to this question since it bears on two objectives we have listed for program budgeting, namely, to improve the information on which to choose between one program and another; and to guide the distribution

of resources between one field of policy and another.

To begin with let us list the budgetary decisions at the local level as follows:

1. Between educational and noneducational activities, e.g. welfare
2. Within education among primary, secondary, (incl. adult) and junior college
3. Within each of the above among fields of study, such as academic and vocational
4. Between specific program elements such as English or mathematics
5. Within each specific program element just how inputs are to be combined.

Since four of the five decision areas listed deal with questions of output trade-offs, we are back to our nemesis of not being able to specify and measure direct output in education. And, even where some correlative proxy, such as test scores may be used, we are dealing with incommensurables. How many points on a mathematics scale are equal to how many points on a reading scale? Again referring back to Table 2, output trade-offs without operational goals attached to them are settled through bargaining processes, or through dictated decisions.

The choice of alternatives then turns on questions of alliances among interest groups, political power, or lack of same. This means that program budgeting information plays a marginal role in guiding the allocation of resources among broad educational policies, as well as between

incommensurable programs. However, since the allocation depends on adversary proceedings, program budgeting information can aid the managers of the school system in what policies to formulate, what questions to ask, and what information to present. But this is an act of judgment on their part that is sharpened by the cognitive map and information flowing from the budgeting system.

There may be some output trade-offs that flow directly from the budgeting process. Two types of policy actions that blend into each other can be distinguished. First, are those broad policies that tend to disrupt the internal relationships of the educational system and/or between the system and its environment. For example, a proposed sharp shift of resources from secondary to primary education could be one such policy. This type of policy remains with the local board and may be guided, but not determined, by informational inputs from a planning-programming-budgeting system. The second type, are instrumental policies, policies for implementing the major policy issue after it is resolved. Such policies on the output side (one type of vocational education versus another) and on the input side (different teacher-pupil ratios) may operate within an area of indifference to all concerned. Within a domain where the effects on the various sets of relationships are not likely "to rock any boats" such choices are more likely to be determined through analytical means. (See Table 2.) This is particularly true of trade-offs

on the input side, provided one doesn't run afoul of teacher militancy since such trade-offs may involve changes in technology. What this means, is in those cases where analytical solutions are possible conflicts are minimal and the administrators may well recommend analytical solutions for "rubber-stamping" by a school board.

One comment on suboptimization at the school board level. Sub-optimization wears two faces at the local unit level. One, the factoring out of programs and problem areas and handling them as having no inter-dependencies. For example, a new program in mathematics will be looked at for program costs and benefits, rather than total curriculum costs and benefits. The other, and more pertinent for this paper, is the sub-optimization over the local school district. The geographical area over which the decision-making body has authority becomes the area for sub-optimization. For example, the local board will tend to expand the area of private and public cost spill-outs, and to limit the area of benefit spill-outs, while fostering benefit spillings. This localization can lead to different programmatic choices than if looked at from the state, or the national level.

These days there is considerable discussion about social indicators and about social priorities in educational expenditures. By social indicators, I assume that we mean measurements of system performance. This program budgeting, when an operational system, can go a long way towards producing. But more is needed. There is a normative judgment required; some measure of what performance should be. Since our interest is in the

difference between what is and what should be, it is necessary to make a judgment on the movement of the system towards, or away, from the norm before public action is taken. The programming system can help in this area, but not determine.

On priority determination, if we cannot calculate the relative merits between major policies we are confined to choices on lower levels. What this means is that priorities, like goal determination, are made outside the budgeting system.

Some Summary Comments

A planning-programming-budgeting system for local schools is, at this stage of the art, more attuned to lower order instrumental policy decisions than to major departures in current practices, the substance of major policy decisions. For the program budget to work, the major policy directives must come from the control center, the school board. For a management system to operate effectively, the managers must want to manage and to use it. Program budgeting has much to offer as a new and improved informational environment. Its informational role in establishing cognitive maps, in focusing attention and conflict, and in bounding the bargaining process has been reiterated. All of this is worthy; is it cost-effective? I believe so, at this point in time more as an act of faith in the worth of better analysis than a judgment based on empirical evidence. The latter is badly needed.

I am reminded of Roland McKean's statement about benefit-cost analysis

as the rabbit in a stew of one rabbit, one elephant - everything else in the public decision process; that we preempt considerable resources spicing a rabbit that remains overwhelmed by the elephant. I would tend to agree with this statement if program budgeting were construed simply as another standard application of systems analysis, benefit-cost analysis, or any other technique for ascertaining relative merit. However, viewing program budgeting as a new informational environment, with feedback properties, for improving the management of school systems makes it look much more promising in counteracting the overwhelming elephant taste in the stew, provided it develop in certain feasible ways.

Just how program budgeting will be designed and applied in any specific school system will be strongly influenced by the managers of that system. One cannot foretell. However, one can hope that two problem areas will be given serious consideration in the design stage. First, how to merge, in a meaningful way, the "rational" and "extra-rational" decision processes discussed above. Educational planning, evaluation, and choices are becoming more complex rather than less complex. Experts and large complex organizations will be necessary even under current decentralization proposals. This means that we must learn to deal with bureaucratic behavior and make it more responsive to the external environment. Second, the program budgeting should take account of the fact that we are generally goal seeking in the decision process rather than goal

implementing. This means its development as a goal seeking, adaptive, and problem-solving system. There are many intellectual and methodological influences around to help in these areas and to contribute to the cost-effectiveness of the new budgeting process.

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Changing Manpower Needs and Educational Obsolescence : Implications for Vocational - Technical Education Planning

Richard H. P. Kraft

This paper is attuned to three major areas of concern:

- 1. The impact of technological changes on the occupational structure;**
- 2. critical issues in developing improved understanding of technological developments, including automation; and**
- 3. implications for vocational-technical education planning.**

The recognition of the growing interdependence between vocational-technical education and industry is a major feature of the educational history of our times. Modern industry rests upon a level of competence which is supplied through technical education at various levels. At the same time, no educational system can supply the required level of skills and competence without receiving the active support of industry. This view reverts at once to the main theme of this paper: namely, the kind of occupational training and technical education the American school system should supply and its constant renewal and development by reference to changes not only in knowledge but in the manpower needs of industry as well.

Given today's manpower problems related to technological changes, it is rather alarming to observe that the efforts of technological developments have neither become an area of primary research concern within colleges and schools of education, nor is there a consensus regarding the impact of technological change on curriculum. As a matter of fact, there seems to be little agreement on the interpretation

of the term "technological change."¹

Higher technical education, as well as vocationally oriented training, have for many years ignored technological changes; they have persisted in preparing students for a world viewed from an inherited, oftentimes local-oriented outlook. Educators have only recently recognized that there is the need for a positive attitude toward space-age technology, thus constructive ideas have been developed regarding the adjustment of vocational and technical curricula in order to prepare students for their role in the world of tomorrow.

Perhaps the most important theme running through this paper is a sense of urgency concerning the measures and attitudes to be adopted by educators and administrators.

¹"Technological change" is defined here in its more technically precise form; it considers two dimensions of change: (a) the technical dimension and (b) the economic-social dimension.

"Technical change is not to be identified with science and discovery. Science gives us knowledge and power for action. It tells us what we can do. Research seeks out the practical and the more or less practicable. Technological change, however, reflects the actual adoption of new methods and products; it is the triumph of the new over the old in the test of the market and the budget.

"Technological change, apart from discovery, is a complex, economic and social process which is influenced by a range of decisions by business enterprises, labor organizations and workers, national and local governmental agencies, the educational system, households, and by the values and attitudes of the whole community. No single body makes a decision as to the rate of technological change in the society, no law can increase it by simple decree." Definition by John T. Dunlap (ed.), Automation and Technological Change (Englewood Cliffs: Prentice-Hall, 1962), p. 4.

The system of vocational and technical education must be endowed with the necessary capacity for change and innovation so that it can adequately respond to the legitimate pressures and demands from modern society.

Technological changes of the past few years have made the relationship of education to our economy not only much closer than in earlier decades, but also more visibly related to the rate of economic growth as well as the life-time earnings of the labor force. One of the many aspects of the relation of the economy to the educational system lies in the connections between occupational structure and the size and character of vocational-technical education. As industry is undergoing rapid changes in its occupational structure and as technological change and automation raise the skill level of jobs, the educational system must also undergo a dynamic expansion. Obviously there are some connections between these broad developments. On theoretical grounds alone we are tempted to suggest that changes in the occupational structure of industry do have measurable effects on our technical education institutions, because the new demand for educated personnel quickly transformed itself into higher enrollments.

There is also a new interest in educational planning. All the evidence suggests that the tide of education is mounting with extraordinary rapidity. One expects, for instance, that in the next ten

years the American higher education system will double. This development will be accompanied by higher costs. The rise in expenditure is justifiable in view of the fact that not only many more people with highly developed skills and abilities will be needed, but that this economy requires a work force, which can adapt itself to ever-changing circumstances. As the economy requires a greater output of qualified manpower, it is impossible to meet that demand without having consequential changes and adaptations through the educational system.

II.

As far as the scope of this paper is concerned, it would be misleading to suggest that neat conclusions to critical issues will be developed which improve the understanding of technological developments and their effect on the economic and political structure.

While an attempt shall be made to examine technological change as it bears upon education, it must be recognized that much of the findings are based on hypotheses that relate to specific and technical situations in various geographical areas and that they must be tested against the characteristics of their context of application.

For the educational decision-maker the relationship between labor and technological changes should be of great concern, as he needs to understand the implications of curriculum revisions in light of technological changes and the far reaching consequences of unemployment.

The introduction of new techniques of production eliminates some jobs (affecting labor requirements) and, also, eliminates occupations (creating changes in skill levels). However, it must not be overlooked, that, at the same time, new jobs and new occupations are being created.

Current labor market data suggest that "there are basically no inherent long term difficulties in the technological disemployment problem, provided responsible managements give warnings of employment

changes or facilitate adjustments internally through retraining or transfer and provided a high level of aggregate effective demand is maintained by government through its fiscal and monetary policies."¹ Thus, for the economist with deep interest in the economics of education it is somewhat reassuring that the most significant employment implication of automation is not mass unemployment.

Concerning the contribution of technological change to current or short-term instances of unemployment, the general level of unemployment needs to be distinguished from the displacement of particular workers at particular times and places. In a recent study Gannon writes that "Changes in the general level of unemployment are governed by three fundamental forces: the effective growth of the labor force, the increased labor productivity (i.e., output per man hour) and the growth of total or aggregate demand for goods and services. The general level or aggregate demand for goods and services is the prime factor in determining the general level of employment and unemployment.

"Technological change affects all three of these major forces, but its main effect is registered (incompletely) through the rise in productivity."²

¹See Colin A. Gannon, et. al., An Introduction to the Study of Technological Change and Its Consequences for Regional and Community Development (Evanston, Illinois: The Transportation Center at Northwestern University, March 1967), p. A-146.

²Ibid., pp. A-101-A-103.

The basic relationships involved are illustrated in the following formula:

$$g_D = (g_p + g_L - d_h) - g_u \quad (1)$$

where g_L = effective percentage growth in the labor force,
 g_D = percentage growth in effective demand for output,
 g_p = percentage growth in average productivity,
 d_h = percentage decline in total hours worked per year, and
 g_u = percentage of growth in unemployment rate.

Gannon concludes that "only when total production, (g_D), grows faster than the rate of labor force growth plus the rate of productivity increase, does the employment rate rise (g_u increases), and hence the unemployment rate falls. For example, for the economy as a whole, if the rate of growth of productivity is 3% per year, the labor force grows at 1.9% per year, and average hours worked per year decline at 0.4% per year, then from equation (1) above:

$$g_D = (3 + 1.9 - 0.4) - g_u$$

$$\text{i.e., } g_u = 4.5 - g_D \quad \dots \quad (2)$$

Equation (2) above simply tells us that total output (and the aggregate demand to buy it), must grow in excess of 4.5% per year just to prevent unemployment from rising."¹

¹Ibid., pp. A-101 - A-103.

"The economist who wants to assist educational administrators in decision-making needs predictive models suitable for testing. The development of such instruments should make it possible to predict the effects of technological changes on occupations. Our position is that a mathematical model of technological change, i.e., a systems model, is necessary to make predictions. Such a model is not easy to construct because of the scarcity of explicit quantitative data on variables involved in technological change. In fact, many economists have expressed their view that the derivation of a complete, closed and predictive systems model is impossible."¹

Focusing on automation and its effects on the occupational structure, we are forcefully reminded that one of the great research omissions in the United States was the absence of government sponsored research in predicting the future of machine counterparts as substitutes for human information-processing. Until recently data on technological and economic availability of these counterparts, had also been overlooked. Research in this direction will provide the basis upon which predictive instruments for future changes in occupations and job contents can be built. Crossman remarks that only when a matrix of information processes and machine counterparts has been developed then the forecasting of future

¹Ibid., p. A-28.

changes in technology can be undertaken.¹ Studies of specific responses which technological processes at the various stages of automation require of skilled personnel may provide the skill information that is needed. A cross-technology investigation of required responses will permit the identification of broad skill categories which in turn could be used for developing suitable guidelines for vocational training and technical education.²

¹E. R. Crossman, "European Experience with the Changing Nature of Jobs Due to Automation", (Mimeo., University of California, Berkeley: Department of Industrial Engineering and Operations Research, December 1964).

²See Louis E. Davis, "Discussion of the Impact of Automation on Occupational Distribution, Job Content, and Working Conditions," (Mimeo., University of California, Berkeley: Department of Industrial Engineering and Operations Research, January 1965).

III.

Much, but not all, of the current educational planning work in the United States is dominated by the social demand approach.¹ The usefulness of this approach for curriculum planning in vocational-technical schools and in colleges and universities is limited by the uncertainties in the relationship between particular occupations and the education that they require. Changes in technological processes may require a change in the educational input for particular occupations, while changes in content and methods of education affect the educational input for the relevant occupations.

¹Four definitions for social demand as abstracted from some of the recent writings in the field are:

- 1) "Social demand for education means the effective demand from places in formal education."
- 2) "Social demand for education is the eminent need of the democratic society (present and future) for the improvement of human capacity by formal and nonformal education."
- 3) "Social demand for education is an expression of securing equal chances for all individuals to get all the education they can absorb," or similarly
- 4) "Social demand for education means the demand derived from the principle of giving all individuals an equal opportunity to get all the education they ask for."

(See Friedrich Edding and Jens Naumann, "A Systems Look at Educational Planning," in Richard H. P. Kraft (ed.) Education and Economic Growth (Tallahassee, Florida: Educational Systems Development Center, 1968), pp. 130-160.

Factors such as the appeal which the several curricula have upon students, e.g. preference for arts or sciences, instead of engineering, necessitate a revision of forecasts, and the constraints in this sector may again lead to a revision of the curricula. In any case, more refined forecasting techniques, particularly long-term ones that are used in identifying the impact of technological changes on skill requirements and demand for labor are needed.

At the same time, a regular evaluation of the relevance of technical curricula to the educational input into the labor market is required. Our recent inquiries in Florida revealed an insufficient refinement of the first type of data and the almost complete absence of valid data on the second type.¹

Under these circumstances, and in light of the persisting uncertainty which is inherent in educational planning, the only general conclusion which we can draw from the social demand approach is an appeal to all educational decision-makers to adapt the structure, methods, and content of technical education to the new situation of a fluctuating labor market requirements. The answer to this problem should not be sought in better forecasting techniques along but in the curricula themselves.

¹We will discuss these inquiries in a later section.

The status of vocational-technical education in the eyes of many industrialists is changing at the present moment. Some firms are quick to see that the educator is a valuable ally; the attitude of others remains more traditional. Although industry, seen as a whole, is more rapidly recognizing that the efficiency of production is in the end merely the efficiency of the producers, there is still the fear that the processes of education may bring forth some undesirable by-products. After all, many industrialists remember that education has a strong literary tradition, and while it had trained men for responsible administrative positions, have either positively despised the skill of the profit-oriented manager, or deliberately kept themselves in ignorance of the market forces and of economic laws.

No one can deny that there is cleavage between the academic world, on the one hand, and the vocational world on the other. It can be seen in the incompatibility between the intellectual and the trade-union wing of the political parties; it turns up inside education itself as the contrast between the "university" and the "State college," and between the various post-high school vocational-technical education institutions and the system of part-time vocational-technical education.

These are all examples of an antithesis between the learned and the labor that enters deeply into the whole of human society. The deep gap between "vocational" and "academic", thus, is by no means a

figment of the imagination. It is real, and a great number of educators and educational administrators are deeply concerned as they see it widening.

How is it significant in the training and education of skilled labor in a changing labor market? First of all, it means that there must be recognition of the fact that occupational training is a respectable role for post-high school institutions, such as junior colleges. Sometimes it seems as if certain segments of our system of higher education price themselves out of the market by unduly emphasizing the academic programs, even though they certainly are important.

The higher order of American society becomes more and more complex with each passing year, and at the same time the lower order tasks are being relegated to machines. The vast array of middle-order tasks will soon furnish the livelihood for the majority of American citizens. The development of area vocational-technical centers and junior colleges is dependent on how successfully they are able to solve the problems of education and training for these middle-level tasks.

Somehow the system of vocational training and technical education must provide a continuous educational spectrum to match the continuous occupational spectrum. For example, a trend of engineering colleges

has developed to avoid extreme specialization since many of them regard the vast spectrum of jobs at the technical level as consisting of clusters of jobs. Curricula in these institutions are usually planned for one or more of those clusters.¹

Also in intermediate technical education a spectrum of jobs is involved. Surveys have found technical jobs which range across a wide spectrum: those where technicians work at quite a highly sophisticated level in research, and those occupations that demand a great deal of manipulative skill and ingenuity with tools and equipment, but require only a modest background in science, mathematics, and engineering theory.²

The important point of this finding is that there are all kinds of technical jobs between these extremes. The gap between the professions and skilled trades cannot be filled by one kind or level of qualified personnel. It is here, where many educational planners and junior college administrators in charge of curriculum, commit a grave error. In their determination to be "academically respectable,"

¹Typical job fields or clusters are: civil technologies, mechanical technologies, electrical-electronics technologies, and industrial technologies.

²See also Charles S. Benson and Paul R. Lohnes, "Public Education and the Development of Work Skills," Harvard Educational Review, XXIX (Spring, 1959), pp. 137-150.

they plan programs only for engineering technicians, raising the level to a point where it differs hardly any more from that of an engineering program in a college of engineering. Many administrators tend to defend this curriculum by arguing that the public image of American technical education is one in which occupational training hardly belongs to the educational world at all. It is seen instead as a minor ancillary of the world of industry.

Regarding occupational and educational relationships three points should be stressed: First, if the educational planner-administrator wants to adjust the curricula in response to technological changes, planning strategies and activities must not only throw new light on the efficiency of firms with regard to their personnel policies, but educational planning must also take a comprehensive look at educational qualifications, the cost of education, and the problem of malutilization of educated labor in various segments of industry.

Secondly, to be realistic, educational planning, which involves the use of detailed occupational and educational data, must revise its outdated approach in terms of rigid educational requirements for technical occupations. Research showed that, for instance, for engineering jobs no single educational qualification or educational "avenue" stands out as the "optimum" education for the particular occupation.

Finally, the administrator in charge of curriculum revisions must realize that firms invest in their educated labor in much the same way as in their physical capital. Inquiries showed that large manufacturing firms in Florida, for instance, plan the use of highly qualified personnel over time in the same way as they plan the use of capital. These companies have recognized that it is of utmost importance to predict the rate of progress of automation and the accompanying changes in skill input.

Within the framework of what sometimes is called "active labor planning," these firms have already worked out plans to predict the employment at various skill levels that will be required in the future.¹

Confronted with oftentimes conflicting calculations regarding the future occupational structure of the labor force, the educational

¹The execution of these plans requires technological (or engineering) expertise; it requires economic analysis and also a great deal of psychology. In order to predict employment due to technological changes in the future, management wants to know:

- a) the present technological methods used for the production of the complete line of products made;
- b) what new processes and methods are on the way;
- c) how fast each new technological development will spread and how large the percentage replacement of each currently used method by a new one will be; and
- d) what new skill inputs will be needed, and what the "skill input profile" will look like.

planner-administrator will have to solve the problem of translating the labor requirements by occupational categories into requirements by educational qualification. Undoubtedly this constitutes a main difficulty since there seems to be no stable relationship between the occupation a person has and the schooling he has received.

Davis is very much concerned about solving this problem and outlines some suggestions for the development of predictive instruments which might help the educational planner-administrator in initiating appropriate curricular changes. He separates short-term changes in occupations and skills from long-term changes. In order to obtain the necessary data, he proposes an intelligence network which would consist of "information links with a selected sample of representative employers, private employment agencies, unions and governmental agencies. This intelligence network would provide reports about changes in selected jobs and their contents."¹

Davis continues that "this network would permit the development of comprehensive information on changing occupational employment patterns in individual industries. Continued sampling of jobs and tasks selected on the basis of an automation taxonomy and subjected to study will permit the identification of changes in skill patterns within jobs. As a predictive instrument, the short-term indicators can be tested when complete and comprehensive data are

¹Louis E. Davis, op. cit., p. 8.

available at longer time intervals."¹

For the educational planner-administrator long-term changes in occupations and skills are even more interesting. Davis, in his paper, points out that the "identification of long-term changes requires the development of predictive instruments having cross-technology capability and linking technology with economic feasibility. This would require us to begin with a formulation of an automation taxonomy."²

In an earlier study a quite different approach was used. Age-earnings-education profiles which showed that the rate of monetary return was higher at the technician level than at the engineering level were constructed. Although some of the data are inadequate, it is tempting to conclude that the large earnings-differential might well lead to a higher demand for educational services at the intermediate (technician) level. In view of the forecast of a changing skill profile, the need for a better differentiation between appropriate functions of vocational-technical education centers, comprehensive high schools and junior colleges should be emphasized because this seems to be an urgent requirement in order for educational services to meet industrial needs.³

¹Ibid., p. 9.

²Ibid., p. 10.

³Richard H. P. Kraft, "Inter-Firm Correlations: The Contribution of Educationally Heavy Inputs to Increasing Profitability," Education and Economic Growth, editor Richard H. P. Kraft (Tallahassee, Florida: Educational Systems Development Center, 1968), pp. 112-129.

IV.

It is a well-known fact that the literature on the economics of education, and more specifically, on technological changes, is by no means scarce. However, there is a shortage of relevant empirical material. Thus, our recent research had two aims: to stress data collection; and, as a consequence of the empirical aspects of our research, to formulate new conceptual tools.

During the interview phase of an industrial depth survey of officials of a representative number of firms reported that technical curriculum must reflect the most up-to-date knowledge in particular subjects.¹ This calls for continuous revision of courses, to take account both of the increase in the amount of knowledge and the rapid change in its nature. At the same time there is a limit to the amount of material which can be accommodated within courses. The extension of technical schooling, which has resulted from the awareness that man in modern society needs more basic knowledge and preparation, cannot in itself solve this problem. The dilemma has reinforced the concept that the role of post-high school vocational-

¹Richard H. P. Kraft, Education and Occupation: Manpower and Changing Industrial Skill Requirements (Tallahassee, Florida: Educational Systems Development Center, 1968).

technical education is not to offer even more knowledge, but, instead, to select from the vast stock of knowledge that which is essential. Such a technique should enable the student to develop the aptitude for acquiring and using knowledge on a continuing basis.

In order that there be a receptive audience for new developments the educational planner-administrator needs to cultivate the right attitudes in his faculty. When the educator accepts an innovation they will be more easily incorporated into the regular process of education itself. It is only in this way that teaching can become an instrument not only for the dissemination of knowledge but for its production, especially in higher education.

An exploration of the awareness of industry's officers and technical institution's educators and administrators to technological changes revealed that in most cases the question of education and technological development had been given careful thought. The technological changes up to now had not been of a kind to induce smaller and middle-size firms, to make any special investigation. They expressed the opinion that it was not possible to distinguish technological changes from other simultaneously influential factors behind movements in the manufacturing industry.

The economists in the firms that were investigated agreed that there are no instruments to aid in predicting the kind and extent of educational changes that will be necessary in the future. They

expressed their belief that this lack of a systematic frame of reference has contributed to difficulties surrounding the various broad policies and policy decisions that effect curricular changes in their response to technological change.

Almost all interviewees (90 per cent) complained that in vocational training and in technical education, "change is too slow in getting accepted." Complete diffusion of successful innovations appear to take "a decade" after the first introduction. In defense of many outstanding post-high school institutions, other representatives mentioned that the rate of acceptance has, however, recently increased considerably.

This acceleration can be observed not only in the introduction of primarily technical innovations, but also in organizational changes and in curriculum materials.

Somers is of similar opinion and calls for an analysis of procedures usually adopted in reaching decisions on the initiation of new vocational-technical education programs. He reports that

"the established procedure for beginning a new course is for the school's director or coordinator to utilize the services of an advisory committee, either a standing group or one appointed ad hoc for this purpose. The committees are to be composed of employer, union, and public members. Although the pressure for establishment of the course may initially come from the school staff, from a group of employers in the community, or from students who wish to enroll in such a course, it is the responsibility, first, of the advisory

committee and then of the implementing school officials to evaluate the real present and future need for such a course on the basis of the best labor market data available.

...Having determined the need, the decision to go ahead will presumably depend on costs and available budget, and on such practical considerations as the availability of space and equipment. Once the school authorities are convinced of the wisdom of the new course, they must they persuade local and state education boards."¹

It was interesting to note that all interviewed representatives of industry felt that major problems in vocational-technical education appear to be the absence of appropriate mechanisms to initiate changes and the need to develop attitudes which would make innovations more acceptable. It is largely as a consequence of new and recent change in attitude towards vocational-technical education that educators at post-secondary institutions have been encouraged to think of educational changes as a continuous, rather than periodic, process, a "rolling" adjustment to technological changes.

It seemed to have been fully recognized that scientific and technological changes not only affect the content of the material, but also the attitudes and habits which should be developed.

¹Gerald G. Somers, "The Response of Vocational Education to Labor Market Changes," Vocational Education, Supplement to the Journal of Human Resources, Vol. III, 1968, pp. 53-54.

In view of possible revisions of the curricula, it is felt that educators at vocational-technical institutions should think primarily of providing generalized basic courses rather than specialized subjects with currently fashionable names and content. Strengthening mathematics and the physical sciences will have to serve the needs of technological changes, including automation.

A large number of educational planners-administrators in vocational-technical institutes and junior colleges expressed a view running contrary to the opinions of industrial representatives. They feel that technical education need not, and perhaps in many cases ought not, to be directed at meeting the technological changes which determine the manpower requirements of the various industry groups. More than 90 per cent of the respondents expressed their strong feeling that technical education -- including the training of highly qualified technicians -- should focus on establishing a broad intellectual foundation which then would enable the student to identify and solve problems he encounters at work.¹

This view ran contrary to the opinions expressed by the first-, second-, and third-level supervisors and top-level industrial officers who were interviewed. Over 70 per cent of the respondents indicated

¹See also Samuel M. Burt, "Conducting Manpower Skill Needs Survey," Industry and Vocational-Technical Education (New York: McGraw-Hill Book Co., 1967). He reports the laments of vocational-technical school directors and advisory committee members concerning the lack of employer cooperation in providing pertinent data on manpower needs.

that technical education "beyond the high school" should meet the specific needs of industry. And 60 per cent of the interviewees added that short-term needs ought to be served by vocational-technical institutions. Thus, employers in manufacturing firms, in transportation, communication, and public utilities, who would generally like to see a wide and broad-based curriculum arrangement, expressed the need for specialists.

The views on the balance between the "theoretical" and the "practical" side of engineering education undoubtedly vary at the numerous institutions in different states. In Florida 80 per cent of faculty members interviewed at schools and colleges of engineering, believed that industry brings a "certain amount" of pressure to bear on colleges and universities in adjusting their technical curriculum to the specific training requirements of individual companies.

Although the pressure exerted by companies in such circumstances is understandable, it is easy to justify the opposite position that since the effect of technological change often is unpredictable, university work should constitute an essentially academic education. In practice, however, such a sharp contrast between the two parts of engineering education is seldom emphasized. It was felt that the main task of colleges of engineering is to educate engineers academically and to make specific arrangements with industry so that practical

training is "related" to the students' education progress.¹

¹While this combination of academic education and industrial training is deliberately designed for students who plan to make their careers in the manufacturing industry, it must not be designed to serve only the more limited goals of a particular industry or company.

V.

The engineering profession has been faced during the past ten years with increasingly new and extremely complex problems. All result in a need for educational program-planning.

Manufacturing processes either are or are becoming extremely complex; advances require that the young technician or engineer has an education based both on the engineering sciences and the pure sciences. The scientific training of past years was based on the pattern of slow evolution by individual development in pace with the existing transition rate from discovery to application. This pattern just does not exist anymore, thus,

the coupling of this factor with the ever-increasing fund of knowledge results in an unquestioned need to reorganize training methods to incorporate more of the scientific approach to engineering. This includes not only an increase in emphasis on fundamental principles and mathematical tools, but also instruction in the use of these principles and tools in their application to engineering problems.¹

More than 75 per cent of educators and administrators who were interviewed anticipate that automation -- or for that matter, any

¹Herbert S. Parnes, "Manpower Analysis in Educational Planning," Organization for Economic Cooperation and Development (ed.) Planning Education for Economic and Social Development (Paris: Office for Scientific and Technical Personnel, 1963), p. 50.

technological change -- will be less likely to come as a tidal wave, but rather as a succession of groundswells that will reach different operations and industries at different times and with different impacts. The same staff members mentioned three built-in brakes that will probably keep the spread of automation in the manufacturing sector to a pace that will not overtax the firms' abilities to absorb it. These three governors are (a) the technical limitations of the design to automatic applications, (b) the limited economic feasibility of automation, and (c) managerial inability to fully understand and take advantage of the opportunities which automation presents.

In designing a "proper" program, engineering faculties find themselves in a dilemma since their students are bound to engage in widely varied types of work. After all, engineering students may be divided roughly into five general groups:

- a. **The engineer-scientist:**
These engineers are creative and devote their major attention to the discovery of new facts about engineering systems and to the recognition of those scientific facts which will lend themselves to engineering development.
- b. **The creative engineer:**
These are the individuals who actually design new engineering systems and put newly discovered principles to use.
- c. **The functional engineer:**
These are the engineers who employ orthodox methods and established principles in the design of conventional details of manufacturing plants and public utilities, and they build, operate, and maintain these plants and the related equipment.

- d. The engineer technician:
Engineers in this group devote their attention to the more routine tasks such as testing, inspection and analysis.
- e. Engineering graduates in non-engineering work:
A large number of engineers in each of the above categories find themselves, perhaps ten years after graduation, in administrative, executive, or ownership posts in industry, government, and utilities.¹

Since management realizes the need for highly qualified technical personnel to be trained in general management, much of industrial management training is carried out internally by the larger firms in the manufacturing group. Only a small number of educators that were contacted (10 per cent) expressed doubts about the quality of training offered in industrial institutions. The majority feel that certain firms at present can impart more knowledge to their technicians and engineering staff than academic institutions can.

As the rate of technological change in manufacturing, contract construction, communication and public utilities increases, the need for more cooperation between those industry groups and technical institutions should grow.²

¹Herman A. Estrin (Ed.), Higher Education in Engineering and Science (New York: McGraw-Hill Book Co., 1963) p. 52.

²A recent survey showed that 21 per cent of manufacturing firms advertise in local newspapers to make adjustments to the shortage of qualified personnel. Only 17 per cent, however, contact the local school system and ask school officials to establish specific training programs. For specific data see Richard H. P. Kraft, Education and Occupation, op. cit., p. 40.

Several engineering colleges in Florida have designed a core of courses in engineering science common to all engineering curricula. It was interesting to find that 50 per cent of the interviewees saw great merit in emphasizing general principles, whereas the other half of our sample opposed the core curriculum on grounds that specialties should not be incorporated into a common course and taught to engineering students as a whole. A more fundamental, or undergraduate, instruction would be desirable but a "single basic curriculum" would be unrealistic because of the diversity of sciences on which engineering practice rests. Several colleges of engineering were criticized by industry for having offered courses or clusters of courses which have little or "no reference to the application of special knowledge in industry."

All large firms in the sample provided special technical training for their qualified employees. Only 10 per cent of all company officials saw any danger in the reliance on internal technical training, even though 65 per cent of the academic staff members pointed out that there are two basic danger-zones. First of all, the on-the-job training tends to be, often enough, of a very narrow kind; and secondly, not enough new ideas are getting into the company, thus, a large amount of information and knowledge may be given but with little or no reference to technological changes.

VI.

There seems to be general consensus among educators and educational administrators that the need for a broad and well-structured technical education curriculum does not arise solely from humane idealism, but rather from urgent practical economic needs. It is felt that the adjustment of the educational structure to technological change is an essential basis for any attempt to prepare this country intelligently for the educational tasks that lie ahead.¹

This represents a potentially serious philosophical conflict between the new manpower interest in education and the traditional view of education's role in a democratic society.

Under the "old" view, the purpose of education was to enable individuals to equalize their full human potentialities for their own sake; in the light of the social demand approach, however, industry, as well as cultural and public institutions, have to be provided with

¹As pointed out earlier, the effects of technological changes are by no means rigidly determined by technological factors. These set certain limits to the kinds of development that can occur, but within these limits there is enough room for considerable variation. Technological changes, thus, offer us freedom of choice in such matters as curriculum changes and job design. From another viewpoint it can be seen as less advantageous since human inertia and the complicated procedures of changing and existing curriculum might prevent us from reaping the full benefit of these changes.

persons having the requisite education and skills.¹

Specialists engaged in educational planning must consider this conflict carefully. One of their major tasks is to convince statesmen, educators and educational administrators that this conflict is not irreconcilable and that the two educational objectives could be balanced.

The survey data indicate that technological change and in particular the development of automation did not involve any serious considerations concerning a closer cooperation between industry and vocational-technical training institutions and schools of technical higher education. More than 20 per cent of all answers received from academic staff members indicated that technical education ought to see its main function in the development of fundamental knowledge, a role not easily reconciled with specific industrial requirements. In a similar vein, sections of industrial officers (19 per cent) show a lethargy and have not seriously considered how vocational-technical education centers and colleges of engineering might assist

¹See also Philip H. Coombs, "Educational Planning in the Light of Economic Requirements," Organization for Economic Cooperation and Development (ed.), Forecasting Manpower Needs for the Age of Science (Paris: Office for Scientific and Technical Personnel, 1960), p. 26.

them in educating future staff members of technological change.

The present lack of interest by industry seems to be an indication that only to a very limited extent does it feel that there is a possibility of influencing the curriculum structure.

Such predictive instruments as described above may be capable of providing the educational planner-administrator with information having long-term implications. The planning specialist not only would be in the position to identify those skills most likely to be replaced in future years, but the instruments would also assist him in projecting long-term educational needs. Such forecasts, then, would provide the needed support for the development of a long-range vocational-technical education policy.

VII.

Two research projects related to technological change and the responsiveness of vocational training and technical education to this change provided for bases for the tentative and, sometimes limited, conclusions of this paper. It would seem to us that at the same time we have raised a number of questions of considerable significance for the further development and improvement of the study of vocational-technical education and the use of qualified manpower by industry. An attempt has been made to show that further and more comprehensive research is desirable from both the local and national viewpoint. This research would yield important information on which educational administrators could base further action relating to the formulation of occupational and educational relationships in order to better adjust the curriculum to changing industrial manpower needs.

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Economic Considerations in Educational Project Planning

Desmond L. Cook

introduction*

Several years ago a colleague in presenting a paper at a convention described it as a "Simple-minded approach to a trivial problem." There were times during the process of preparing this paper that a similar feeling came to me with regard to the substance of what I would like to present to you this afternoon. Second thoughts, however, convinced me that the substance is not a trivial problem nor are there really simple-minded approaches to it. To some extent, the majority of my remarks may be old hat to this audience in view of the wide experience many of you have in project planning. To you, the substance will seem trivial and the approach simple-minded. My experience reveals, however, that there is a large audience which is not here and does not possess the background that you do. The substance presented may provoke a great deal of thought within that audience.

The general thesis that I would like to pursue is that a fairly large number of persons in the field of education do not give sufficient thought to the economic function in the process of project planning. The economic function referred to here is more simply expressed in terms of "costs" or still more simply "dollars." It is my contention that more attention must be given to this function in project planning since the funding agencies and the agencies receiving the funds are both working within

*The author wishes to express his appreciation to Mr. William Loeber, Research Associate, EPAC, for suggestions to be included in this paper.

the "limited resource" case. Insufficient attention to the economic function in planning projects may create problems for both agencies, a point to which I will return later.

The focus of my remarks will be primarily upon those activities commonly called projects. In general, projects are activities which are goal oriented, finite in duration, nonrepetitive in nature, and consist of a series of parallel and linear tasks which are accomplished by the application of resources (men, money, materials, etc.). We will consider the project to be a system and therefore amenable to many of the principles and concepts of a system; (e.g. system analysis, system design, and related concepts).

Time does not permit a detailed presentation here of the conceptualization of the project as a system. Persons interested in this idea should read the paper the author presented at the Operations Analysis in Education Symposium sponsored by the U. S. Office of Education in November, 1967 (2). Although focusing upon projects, much of what I want to say can be equally applied to efforts commonly called programs.

The problem of economic functions in project planning is highly related to a topic receiving increased attention in the field of education at the present time - that of cost/utility or cost/effectiveness. As noted above, we are almost always operating under the limited resource case and are therefore highly interested in making sure that, for the dollars expended, worthwhile results are being secured.

Time does not permit a complete discussion of the problem before

us, so I have selected out only three general areas for discussion. These are economic considerations in (a) project selection, (b) project termination, and (c) long-term funding.

Economic Considerations in Project Selection

As a preface to the point I would like to make under economic considerations in project selection, let me present two related points.

A major consideration in any discussion of project planning is a recognition of the fact we must always be concerned with the three variables of time, cost, and performance.

A fourth variable, reliability, is often identified as one of the major variables of concern. Reliability here means that the systems produced maintains a consistent performance over time. For example, we might meet performance standards by achieving gains in academic achievement as a result of a new program developed through a project but the gains do not remain over time. In this case, we would have achieved our performance standards but they would not be reliable. For our discussion here, the concept of performance includes this variable of reliability.

Each of these three variables can be considered as being independent of each other but at the same time having important interrelationships to the extent that constraints upon any one have an important effect upon the others. For example, if a constraint is upon time, or schedule,

then the project planner is free to manipulate only the other two. If the constraint is upon cost, then he can manipulate only time and performance. Recognition of the interaction of these variables leads to at least three conditions under which a project planner might possibly have to operate.

1. In one condition, there is a specified level of performance to be achieved (output, product quality, etc.). In this situation, the project planner must determine the most economical combination of resources which give a high probability of attaining the stated objectives. This situation often occurs when responding to an RFP from a funding agency.
2. In a second condition, there is a specified limit on available resources and an open-ended output objective. In this situation, the project planner has to combine the limited resources in such a manner as to maximize the output achieved from them. This situation often occurs in certain RFP situations when a dollar amount may be fixed or in some situations which contain dollar restrictions.
3. A third condition is a combination of the first two in that there is a specified amount of resources available to attain a specified output. In this instance, the project planner has little control, perhaps even none, over requests for funds or what he is required to produce. This situation again often

occurs in RFP situations where both dollar amounts and performance output are specified. In the above three cases, we are concerned with the effective and efficient uses of resources under constraints that may be operating in a specific project situation.

A second major point to be kept in mind centers around the idea that in perhaps the majority of cases in education, and perhaps most particularly in the cases of the unsolicited proposal as opposed to a proposal responding to an RFP, any project plan developed is usually an ideal plan. This ideal plan focuses primarily upon the output or performance variable. Consequently, most of the initiator's time and effort is spent on problem statements, objectives, procedures and data analysis. Less time is spent on thinking through the time and cost dimensions except insofar as they are needed to achieve the performance objectives. The economic function or role that the project planner has in these situations is often not considered. This situation is perhaps not too unusual since the project planner is most often a substantive specialist who has had little or no experience with the management function. Therefore, he is not likely to be overly concerned with alternative plans that might be developed which give equal attention to the three variables of time, cost, and performance. In short, the concern is primarily with maximizing the performance variable and not with the most economical combination of resources. Hence, the decision maker

(i.e., the funding agency) is not able to choose between alternatives and, therefore, is not in a position to make most efficient use of the dollar.

With these two points in mind, let us now turn to a behavior that a project planner might exhibit as he undertakes to develop a proposal where attention is given to all three variables rather than to just one - that of performance. The behavior is that of developing alternative time, cost, performance plans and not just simply an ideal plan.

The basic idea to be presented derives from some early thinking associated with the development of the PERT/COST system (5). For those persons unfamiliar with the basic nature of PERT (Program Evaluation and Review Technique), it is recommended that they read the monograph prepared by the author for the U. S. Office of Education (3). The specific idea presented in this system was that time-cost-performance options could be developed by the project planner. The essence of the procedure is presented in Figure 1.

In this figure, three different alternatives or options are considered with regard to the same project. Under Plan A there is a sequence of jobs which perhaps represent the ideal situation since the risks involved are relatively low but the time is rather high. In Plan B it can be seen that certain activities formerly performed in an ideal order have now been placed in parallel. The net effect on the three dimensions is

Figure 1. Time-Cost-Performance Alternatives in Project Planning

Plan	Network Configuration	Time	Cost	Performance Risk
PLAN A	<pre> graph LR Start(()) --> A((A)) A --> B((B)) A --> C((C)) C --> D((D)) C --> E((E)) E --> F((F)) F --> G((G)) </pre>	2 years	35,000	Low
PLAN B	<pre> graph LR Start(()) --> A((A)) A --> C((C)) B((B)) --> C C --> E((E)) D((D)) --> E E --> F((F)) F --> G((G)) </pre>	1 1/2 years	55,000	Medium
PLAN C	<pre> graph LR Start(()) --> A((A)) A --> D((D)) B((B)) --> D D --> E((E)) C((C)) --> E E --> F((F)) F --> G((G)) </pre>	1 year	75,000	High

to reduce the time but to increase the costs and to generate a larger degree of risk with regard to performance. In Plan C the network configuration has been further modified with time reduced but costs increased and greater risk introduced with regard to performance. The principal point to be made with regard to this illustration is that when we maximize one variable, there is an important effect upon the others. At the same time, we can study the possible alternatives available to us as we develop project plans.

What I would like to emphasize here is that in most cases persons in the field of education develop proposals primarily on the basis of what might be considered as the ideal plan, or what I have chosen to call Plan A. It has been my experience in helping educational personnel to prepare proposals or plans that very few of them approach the situation in terms of consideration of alternatives such as those exhibited in the illustration. Therefore, when asked to prepare proposals under certain constraints, and most particularly economic or cost constraints, proposal initiators or planners tend to follow previous behaviors by trying to maximize the performance dimension - or to come up with the ideal plan.

If asked, perhaps many of my educational colleagues would concur with the idea that we should go with Plan A as illustrated since it is the lowest cost figure and performance risks are minimized. Overlooked

in this decision is the fact that personnel resources are tied up for a much longer period of time than is the case in the other two alternatives. Tying up personnel and other types of resources does have an economic impact on the organizational unit conducting the project in that these personnel and other resources are not available to carry out other functions of the organization. The problem is sometimes overcome by the use of institutional contributions to defray the cost of replacement personnel. This procedure seems efficient until one considers that the replacement personnel often do not have the skills and competencies of persons actually working on the project. The commitment of professional personnel to the project over a long period of time may mean that some classes of courses have to be suspended until the project is finished, which also has its economic impact in terms of students being unable to secure courses and thus completing their degrees on schedule.

Those of you familiar with project planning and selection procedures in business and other governmental areas perhaps recognize that, in many cases, personnel planning projects are asked to develop alternative plans showing time, cost, and performance dimensions so that more effective decisions can be made with regard to allocation of limited resources. In some cases, the desirability of having the final product or output available early will outweigh the economic or cost factors.

even though the final product may be produced under a high risk condition. I would suggest that if you have not read either the history of the Manhattan Project (4) or the Polaris submarine development that you do so since time was the major variable to be considered in both ventures. The plans followed were selected primarily upon the need to have the final item available as early as possible under circumstances of a great deal of uncertainty as to what the end product might look like or if it would ever function properly.

The question might be raised - Do we have similar kinds of situations in the field of education? It would be my belief that at the present time we do. There are some situations in education that cannot wait until the "ideal project plan" is carried out. The problems are too urgent to follow the linear model of research, development, dissemination, and reduction-to-public practice. We may have to recognize that some of these steps will have to be skipped in our planning effort. In so doing, we may have to expend resources at a greater effort than desired, accepting the performance risks involved so that we can begin to deal with the problems before us. We may, therefore, have to choose Plan C among our alternatives rather than Plan A. To make our decision, however, we must establish our objective. That is, are we going to insist upon maximized performance? Minimized costs? Minimized time? If our objective is to secure a result as quickly as possible then we will probably go with Plan C, accepting the additional costs and performance risks as part of

our decision. If we put a cost constraint upon our project equal to that shown in Plan A, then that is the choice which we will accept. In either case, we need to establish our objective before deciding upon an acceptable plan.

One major limitation, however, accompanies our operating in this manner. That limitation is that the alternatives with regard to time, cost, and performance are not known or available to the decision maker because they are not simply generated. Perhaps what we should begin to do is to ask persons preparing proposals or plans for funding by educational agencies, such as the U.S. Office of Education, to present to these agencies alternative plans which can be considered. In one sense, this idea is being implemented at the present time, but only indirectly. For example, there would not be much doubt in my mind that a variety of proposals presented to USOE in response to an RFP do represent in effect, alternative plans which reflect different combinations of time, cost, and performance. As far as I know, no one has researched this area to determine to what extent this is true. The idea is also being implemented to some degree in the regional educational laboratories by asking that budgets be submitted which reflect accomplishment under optimum budgets, normal or maintenance budgets, and reduced funding levels. It should be noted here that the variable being manipulated is basically one of cost or dollars.

Considerations in Project Termination

In addition to the problem of deriving alternatives for project

plans which reflect possible time and performance factors for costs involved, consideration must also be given to the economics involved in project termination. No one likes to have the responsibility for terminating the work of a professional person once under way. It is important to recognize, however, that the situation might well arise where further investment of dollars into a project where results are not forthcoming may be the best decision that can be made. Continued support of such a project acts as a drain on the limited resources available and prevents the organization from using these funds to support a different project where results might be more fruitful. Further, changes in objectives and the allocation of resources or dollars to these objectives would result in the termination of projects. I am sure you and I can both cite instances in the military complex where both of these factors of lack of success and changes in objectives have resulted in project termination. From my own experience, there is only a limited number of cases in the educational situation where a project once funded has been terminated for either of the above factors. It would appear to me that if most effective use is going to be made of the large but limited amounts of Federal funds available for educational research and development, then we must give greater attention to the problem of project termination as a means of making better allocation of these scarce dollars.

A major problem here is establishing procedures for terminating projects which are not producing useful results. Buell (1) has outlined some of the questions which might be asked about a project before such

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a final decision is made. One procedure that also might be utilized is the "milestone report" system. Certain major accomplishment points, or milestone, are identified at the start of the project and the performance requirements stated in advance. Should there be a failure to reach the performance specifications, a decision might be made to terminate. For example, if a large-scale curriculum project is dependent upon the successful development of measuring instruments, the specifications for the instrument in terms of validity and reliability should be established early. Once the instrument is developed, we might examine the obtained reliability and validity to see if the performance specifications had been met. If not, then we would have to consider what action would be taken? Continue with a less than desirable instrument? Put additional time and money into bringing it up to performance specifications? Cancel the balance of the project since we would not want to proceed with further investment when we have an idea that the results based upon a less than perfect instrument would not be too meaningful? There are problems associated with this procedure, particularly around the recruitment and retention of personnel if there is a possibility of the loss of funds midway through the project if performance specifications are not made. On the other hand, it does not make much sense to continue to spend scarce resources on what appears to be a non-useful result.

Considerations Centering on Long-Term Expenditures

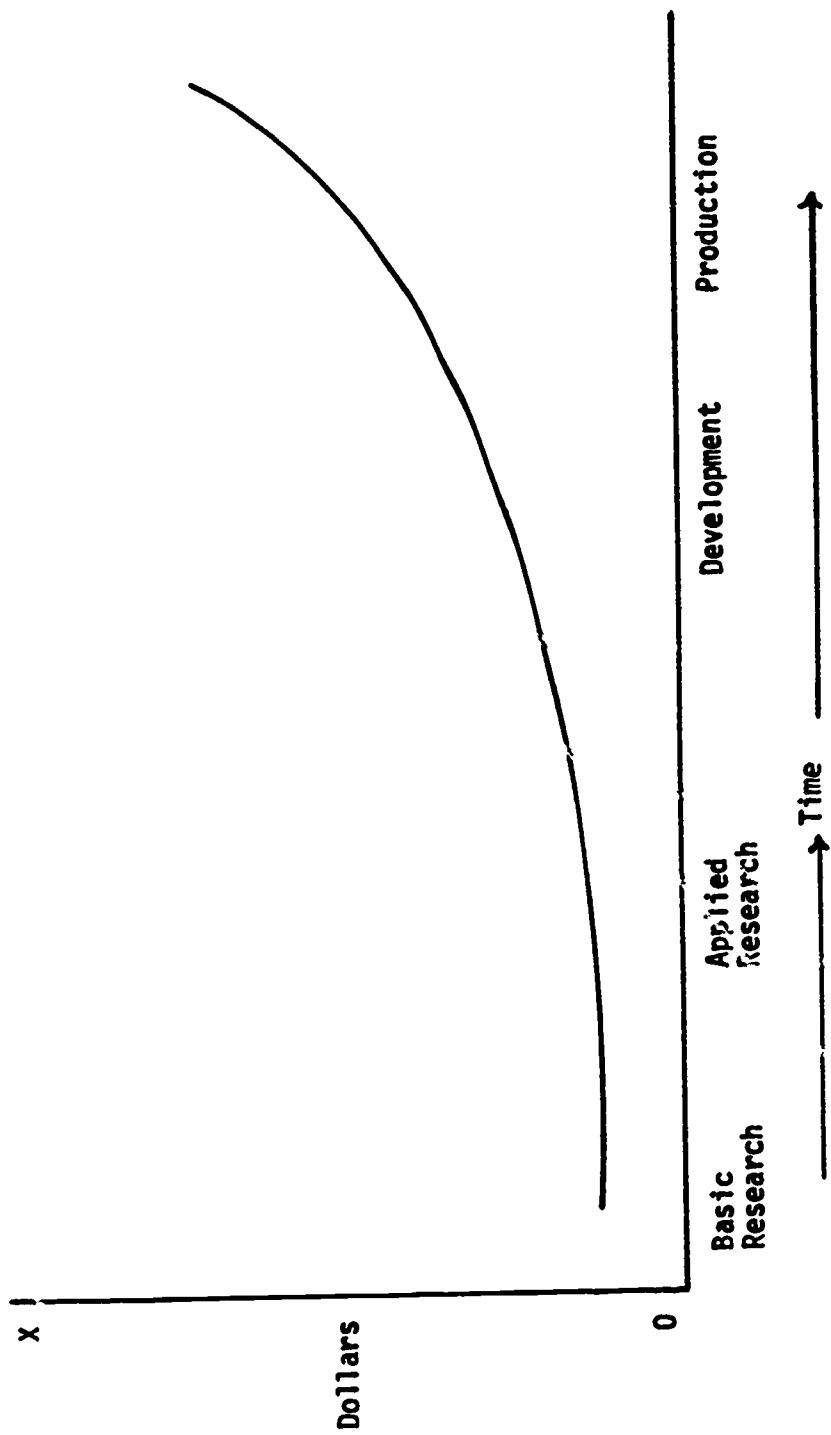
In addition to the selection and termination problems, there is a

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third economic consideration that I would like to discuss albeit briefly. This consideration centers around the idea that we must be aware of the long-term dollars that would be needed if a particular planned project effort is successful. Some time ago in a Congressional hearing, Charles Hitch (6) pointed out that the initial costs for the research relating to penicillin were relatively small. The subsequent costs for the development and laboratory production of penicillin, however, showed an ever-increasing curvilinear relationship as shown in Figure 2. The curve presented is a rather generalized curve designed to show that there is an ever-increasing cost figure associated with movement from basic research through development to reduction-to-public-practice. In actuality, there are different cost curves in the sense that as research costs tend to diminish over time, development costs tend to increase. As development costs increase, then production costs increase. Thus, there is a series of overlapping curves between the several functions.

It is generally recognized in the military-business complex that development costs are always at a greater level than for the research phase. Consequently, attention is paid in the original projects planning phase to the possible long-term commitment of funds if the research produces useful results. From my experience, I think that education is just beginning to recognize this fact of life. Unfortunately, some

Figure 2 - Projected Long-Term Cost Curve



of my colleagues don't like what they see. For example, some object to the level of funding involved in support of the regional educational laboratories feeling that this money might be better spent in basic and applied research. The general nature of the regional laboratories and the purposes for which they were created will require quite high levels of funding simply because development costs are expensive. The lessons learned from the military-business complex regarding expanding development and production costs following successful research efforts should be in our mind as we make our decisions to fund a particular educational project or plan. In brief, long-term costs are more than that represented by the budget associated with a particular project plan.

One solution to this problem would be to request from project planners a projection of costs over time. The PPBS system provides a vehicle for making such projections. It is granted that in some cases, the projections might be not much better than "guesstimates" but even that projection would be useful to a funding agency in planning future expenditures in the event that a project is brought to successful completion.

Conclusion

In conclusion, let me say that the three ideas presented above with regard to economic considerations in project planning represent some of the concerns we have in our Center. Solutions to the problems

are of great interest to us. Business and the military have been working on solutions to the problem of most effective allocation of dollars as they relate to the three considerations presented in this paper. Operational Research techniques, dynamic programming, and heuristic models are being developed to make the decision process more efficient. Perhaps my remarks will stimulate each of you to begin to devote some time and energy to solving some of the problems involved so that the most effective use of the limited dollars available to us can be made as we proceed to plan those projects and programs which are designed to maximize the educational system.

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Economic Planning for the Future Development of Educational Facilities

C. W. McGuffey

It is indeed a pleasure to have the privilege of appearing at this Conference. My topic is somewhat different from those already presented. If there is a central theme to what I have to present today, it is that a major concern of educational facilities planning must be to make the most effective use of available resources both in their construction and their utilization. In other words, the choices we make in facilities planning should be conditioned by economic, as well as, educational and architectural considerations and such choices must be made with a long range perspective.

In making this presentation, it seems desirable first to make reference to the rapid technological and social changes which have caused, at least in part, the ferment and subsequent stirring to action in the field of education and more particularly in educational building planning.

Much has been said about these changes and about their implications for education as we face the future. As a matter of fact, it would appear that the only real certainty that educational planners can depend upon is change itself.

Creation of New Knowledge

A critical factor giving rise to significant change in education is the rapid discovery and creation of new knowledge. Your speaker has heard

scholars on more than one occasion state that man's knowledge was doubled the first time around 1700. The second doubling took place by 1900, the third around 1950 and the fourth in 1920. Sarnoff says that both science and technology will advance further by the year 2000 than in all of the time since man's creation. The significance of this is that new concepts, methods and approaches in education are essential if the responsibility for educating our citizenry is to be fulfilled. Furthermore, the resulting changes in education will produce radical changes in school building design. Totally new concepts about planning school buildings may be in order.

Someone has said, "The balloon carrying an electronics laboratory, the flying box with the dying dog and the men orbiting the earth in a space capsule are symbols of the great explosion of knowledge that has taken place in our generation." These events also symbolize the technological revolution taking place around us. Today thousands of thundering horses thrust great jet planes across the sky. What was once a rural society and an agricultural economy has been replaced by an urban society with an industrial economy. A new morality competes to replace the old and the freedoms so greatly cherished by our forefathers are threatened both from without and within. Our society is torn by violence and the threat of self destruction. And so, education is more than ever looked upon as the means for society's betterment. New Programs, drastic changes to old methods, extensions of educational opportunity both upward and downward and continuing education are perceived as partial solutions to

our many problems.

Population Change

The Bureau of the Census has projected the total population of the United States to be approximately 241 million for 1980 and around 300 million by the turn of the century.¹ Historically, the population of the United States has become increasingly concentrated in the urban communities and the metropolitan areas. In 1790 there were 24 urban places in this country and they contained about 5 per cent of the nation's population; while in 1960, 70 per cent of the nation's population were in 6,000 urban places. Even more phenomenal has been the expansion of the metropolitan population from 24 million in 1900 to 126 million in 1960. The metropolitan population is expected to increase to 170 million by 1980.²

Each year in the past decade 30 million people have moved from one house to another - about 20 million to a new location in the same county, 5 million across state lines. There is every reason to believe that this mobility will accelerate as new industry springs up in new locations across the country.³

¹U.S. Bureau of the Census: Current Population Reports, Series P-25, No. 286 (July, 1964).

²Morphet, Edgar L. and Charles O. Ryan, Prospective Changes in Society by 1980. Denver: Designing Education for the Future. 1966. pp. 24-30.

³AASA. Schools for America, Washington, D.C.: The Association, 1967, p. 17.

School enrollments, which are largely dependent upon the number of persons in various school age groups and their enrollment rates, have continued to increase. From 1955 to 1965 enrollments in grades K-12 increased from 35,280,000 to 48,744,000 for an increase of about 1.3 million per year. Projections to 1975 indicate an increase to 53,600,000 or an increase of a little less than 500 thousand per year. Thus, while enrollments will continue to increase, the rate of increase is expected to decline.⁴

Facilities Problems Caused by Change

Some of the facilities problems created by the changes outlined in the foregoing analysis are:

1. Continued increase in enrollments will be experienced at all levels but at decreased rates. The increase will be sufficient to keep school construction needs at high levels. Projections indicate that the current backlog of need is more than 12 million student stations and the rate of growth is about 1.3 million students per year.
2. The acceleration of population mobility will cause problems of the relocation of school facilities in order to provide for population shifts. Great care in facility location can help to avoid early obsolescence and ineffectiveness in the development

⁴Office of Education, Projections of Educational Statistics to 1975-76. Washington, D.C.: U.S. Government Printing Office, 1966., p. 5.

of educational buildings.

3. Continued expansion in the accumulation of new knowledge, rapid obsolescence of jobs, increased leisure time, expanding technology and increased automation has affected and will continue to affect curriculum development in the schools. The implications are that these developments will continue to affect every feature of the school plant.

The changes will call for major modernization and perhaps extensive replacement of existing school plants. As a matter of fact, if and as the rate of enrollment increase slows down and the tempo of technological and social change accelerates, the disposition of existing buildings will require major attention.

In essence it would appear that for the years ahead the major problems in facilities development will be to:

1. Provide space to catch up with the present backlog and provide facilities for increasing enrollments.
2. Provide for the relocation and replacement of facilities to meet the shifts in population.
3. Provide for the improvement and replacement of facilities to combat educational and technological obsolescence in both existing and newly constructed facilities. The abandonment rate is currently about 30 per cent of the rate of completion of new facilities.

Economic planning for the future development of school buildings should be concerned with the creation of educational facilities which meet desirable physical environment goals, provide adequately for today's educational requirements, have the potential for change to meet tomorrow's needs and, at the same time, utilize a minimum of available resources. To achieve this goal, educational, architectural and economic planning are considered inseparable elements in the process of planning for adequate school buildings of the future. Each must be considered an interdependent element in the planning process if available resources are to be effectively used.

School Building Obsolescence

As we look to the future, early obsolescence of school buildings in whatever form must be averted. Past experience can serve as a useful guide as we plan ahead with this goal in mind. This experience has identified certain factors as major contributors to school building obsolescence:

1. Neighborhood deterioration - changes occur in the neighborhood which may be hazardous and unpleasant to school children. Business activity may have made the streets unsafe. The presence of industry may have filled the area with noise, fumes, smoke, traffic, and dirt. Perhaps the school age population has moved away. The major factors involved here are changes in the uses of land and in the age structure of the people in the community. Because of expansion by business and industry,

housing may be displaced. In other instances single family dwellings may be replaced by apartment houses resulting in the displacement of families with children.

2. **Site inadequacies** - Perhaps crowding on the playground, lack of adequate parking facilities, near accidents on the street or the lack of space for needed building expansion have indicated that the existing site is too small. Attempts to compensate for deficiencies such as the provision of playground elsewhere in the community, the construction of walls and fences or roping off adjacent streets during school hours may help to relieve matters somewhat. None-the-less, it is clear that site obsolescence exists and that the quality of education will suffer due to the lack of adequate site space.
3. **Obsolete building equipment** - The building equipment to which I refer includes the various mechanical, plumbing and electrical service equipment built into or integrated with the construction of the building. Various building services such as heating, ventilating, air conditioning, lighting, fire protection, and sound control are provided by this equipment. Technological advances, increased standards of performance, as well as the standards prevailing in most homes and business houses in the community, can cause dissatisfaction with building services. Generally speaking, however, building equipment

in most schoolhouses is obsolete or worn out long before replacement is undertaken. Recent technological advances and trends in school building design can expect to accelerate the rate of obsolescence of building equipment.

4. Educational inadequacies - When the building is ill-suited to the on-going curriculum and organization of the school, obsolescence has occurred. Usually such a state of obsolescence is a matter of degree and may be difficult to communicate to those who are in a position to do something about it.

Such obsolescence may be reflected in the capability of the building to accommodate new equipment such as teaching machines, audio-visual devices, instructional television or other learning media. Perhaps the school has a plan designed for better staff utilization that should be implemented but the building's walls are in the way.

In recent years, there has been a rash of innovations focused on extending the school program upward and downward, lengthening the school day, and the school year, broadening the school's program and individualizing instruction. No facet of the school has been left untouched. These innovations, should they become common place, signal obsolescence in existing school plants.

Strategies for Planning to Avoid
School Plant Obsolescence

Economic planning for the future development of school buildings will seek to avert the obsolescence due to the factors here described.

I have no solutions to recommend but would dare to offer these suggestions:

1. To avoid the most prevalent causes of site obsolescence, economic planning would require the purchase of school sites well in advance of need. Site purchases should be made long before an area has developed so that the school plant can be located in the right place and constructed at the appropriate time. Care should be taken to study future land uses, direction of the growth of business and industry, highway development, residential expansion and population growth. A long range master plan is needed and land range planning is essential to this process.

Also, I would add that an adequate amount of land area should be purchased to allow for future expansion and for unforeseen needs. Land is fast becoming a scarce commodity since no more is being produced.

2. Building equipment installed in contemporary schoolhouses will become obsolete at an accelerating rate. It would appear that much of a building's integral equipment should be planned for early exchange with interchangeable parts in an integrated

building system. Such components for exchange would have a short life expectation based on a system of planned obsolescence.

3. Obsolescence due to educational inadequacies in a school building is likely to occur at a more rapid rate. To further complicate the problem, we must admit that we are totally incapable of predicting the future so precisely as to build a container for education that will hereafter fit its contents. We must accept education as a fluid product and design a container appropriate for it. There are building proto-types that exemplify this concept. The open space school is an effort in this direction. The loft plan with movable walls and folding partitions is another. The School Construction Systems Development project in California perhaps has the greatest promise for effectiveness. Many states including Florida are following the example of California. Needless to say that much experimentation is still needed. As long as the tempo of change is maintained, final solutions are unlikely. Each school building must then be tailored to fit its own specific educational requirements. Architectural solutions will project today's curriculum and instruction needs and incorporate those features which increase the change potential of the building and its integral equipment for tomorrow's requirements.

Existing Buildings

Many existing school plants because of change are well beyond salvage value. Planners must be prepared to advise when this stage is reached and when a building should be discarded for educational uses. Castoldi and Linn have offered solutions which are helpful. Their methods should be a part of the consideration for the abandonment of school buildings by those who would become involved with the problem. Your speaker has developed a basic formula for use as a guide in making the decision regarding the economics of abandoning or retaining an old school plant. The decision to abandon ultimately becomes an economic one. Therefore, the basis for the decision should be the annual cost per square foot of building space for the life expectancy of the modernized building related to the annual cost per square foot of building space for the life expectancy of its potential replacement. However, it must be clearly established that the modernized facility will perform as effectively from an environmental and educational point of view as its potential replacement. The mathematical formula is thus:

$$\text{If } \frac{C_m}{L_1 \times B_{s_1}} < \frac{C_r - S_e}{L_2 \times B_{s_2}} \quad \text{Then retain the old building and modernize it.}$$

The factors in the formula are as follows:

C_m is the cost of modernizing the old building in all of its aspects including structural, health, safety and educational

- L_1 is useful life expectancy in years of the modernized school plant.
- Bs_1 is square feet of space in the modernized school plant.
- Cr is cost of the new plant to replace the old school plant.
- Se is salvage or sales value of the old school plant.
- L_2 is useful life expectancy of the new or replacement facility.
- Bs_2 is square feet of space in the new or replacement facility.

Much has been written about building schools for the future. Perhaps our efforts in this direction manifest the eagerness of those who plan school buildings to get on with the business of building the schoolhouses we do direly need. Our apprehension and eagerness perhaps surpass our vision for we must plan to accommodate an educational program which we are unable to describe. One planner put it aptly when he said "Education must prepare the minds of students for work which does not exist and whose nature cannot be imagined." It is for this unknown quantity that planners must produce school buildings for the future.

What will the school building of the future be like? I see it as a structural envelope with few, if any, interior partitions and walls loaded with electronic gear and planned for highly individualized instructional activity. Spaces for group processes and democratic action will also be provided to enhance the socialization of pupils. Its structure and envelope will be architecturally planned using a building system of prefabricated interchangeable components.

Thank you for letting me come.

Approaches to the Analysis of the Demand for Higher Education : A Tool for Educational Planning

Robert Campbell

This paper is, in a sense, a report on the work of a group of economics faculty and graduate students supported by the Center for the Advanced Study of Educational Administration at the University of Oregon. As some of you know, this is one of several Research and Development Centers financed by the U. S. Office of Education. I am particularly in debt to Professor Barry Siegel, with whom I have worked most closely and to my research Assistant, Mr. Robert Fischer. In considerable measure this paper is simply my account of the way in which Barry and I have gone about our work with the Center and owes as much if not more to him than to me.

The Economic Analysis of Education.

We began our work by asking ourselves: how can an economist most usefully characterize or conceptualize the educational institution in order to bring his alleged skills to bear on its problems? The rather obvious answer brought us immediately into an area still clouded with controversy--that is, we chose to view the educational unit as a firm within an educational industry. This firm buys the services of various resources in one set of markets and by various processes of transformation and combination, provides educational "products" which it "sells" in another set of markets. We were aware, of course, of a variety of difficulties

inherent in the nature of the educational institution. It is not a profit seeking enterprise, it does not always "sell" its product and even if it does, it sells at less than cost. Furthermore, the ambiguous and complex nature of its product or products and the involvement of the consumer in their production, and even worse, the absence of anything resembling a production function in the usual sense, to mention only a few complications, make it difficult to apply any simple theory of the firm to education. On the other hand, the economic model in its most abstract form---that of rational choice under constraints---appeared to us to provide a potentially useful tool, in Mark Blaug's words, "to separate the available information into distinct boxes so as to indicate its relevance." [1-181] In this belief we were reinforced by several lines of development within economics. In the theory of the firm itself, Oliver Williamson [14], and others, had pointed out that the substitution of utility maximization for simple profit maximization could enable multiple goals to be incorporated in the standard version of rational behavior by the firm. As a possible pattern to follow in untangling the ambiguous web of the educational product Kelvin Lancaster with his arguments on the technology of consumption and the analytical separation of the characteristics relevant to the consumer from the product itself seemed to point out a potential design [10]. And again, the

application of cost-benefit analysis and related techniques for weighing the consequences of alternative actions to a wide variety of decision problems not ordinarily viewed as with the bounds of economics provided further encouragement. Notice here that I do not stress the literature on the rate-of-return to investment in education nor the arguments on the role of education in generating an otherwise unexplained residual in economic growth. We were aware of these arguments of course, as we also become aware of a variety of attempts to model entire educational systems or to integrate them into comprehensive manpower planning models. But our aims were and remain much more modest: to try to construct a model of the individual educational firm that could help to identify and, hopefully, to estimate those variables that could be of special importance in the decisions of the unit. While this topic is given considerably more detailed treatment in Siegel's paper, "Towards a Theory of the Educational Firm" [14] and has since been the subject of several other papers which reinforce the judgment that it is by no means an area of general agreement, [9, 11], I will try to sketch in just enough of the argument to provide a context within which to view some of the work on the demand problem as one particular facet of it.

As a decision unit, the educational firm is involved in a process of interaction with many other decision units. As

Mary Jean Bowman points out, however, in examining this interaction "...the economist is not concerned as is the psychologist, with explaining individual behavior per se. If enough people behave as if they were economically rational, that is quite enough, provided we are dealing with multiple decision units." [2-120] It is, of course, precisely this as if approach to explaining the buying behavior of groups of consumers---"multiple decision units" ---that characterizes conventional demand analysis in economics. But before we can apply this approach to education we must ask whether the appropriate conditions are met. Here I think it is helpful to draw a distinction, at least for this country, between higher education and compulsory primary and secondary education. While both areas of education are involved simultaneously in individual market processes and in collective political choices as well, the former area provides us with a much better "fit" to the dimensions of the firm. By persuading society to create a virtual monopoly for it within the relevant market area, the typical lower school district has been able largely to by-pass the type of problems of marketing its product faced by the firm, while its consumers find their choices both collectivized and narrowed to attempting to influence the quality rather than the quantity of education they "buy" through their votes. [13, 15] It is true that the growing relative importance of public institutions of higher

education is enhancing the role of collective choice in this area, but colleges and universities still choose to market their products at a price, if only a nominal one in many cases, and they do, in a sense, still compete for students. In a parallel fashion, students and their families still are able to make decisions about college attendance. In both instances the choices are closely constrained but not to the extent that they can be forecast or predicted from a knowledge of these constraints or boundary conditions alone. Furthermore, there is interaction between choices in the sense that any individual decision is only provisional or contingent relative to others and markets function in coordinating these choices. In other words, we have a set of "economic" problems in the strict sense of the word economic and not in the sense in which some of the earlier and simpler educational planning models sought to generate uniquely optimum outcomes that were already implicit in the boundary conditions of the models. [8]

The Economic Theory of the Demand for Education.

Now, as seen from the position of the educational firm, the demand problem is primarily that of forecasting enrollment. As may be the case of an individual firm in any industry which is not purely competitive, however, the enrollment forecast of an institution of higher education is not a simple function of industry

demand alone but depends upon the relative price and product policies of all such firms, together with various types of non-price controls they may choose to exercise such as variable admissions standards or other limitations on enrollment. Rather than to move directly into these complexities, however, we chose to deal first with the apparently simpler problem of industry demand---with the total demand for enrollments in higher education in the U.S. As we examined the available studies of educational demand we found, unfortunately, that few were structured in such a way as to be suitable for testing hypotheses derived from demand theory. For short-range forecasts, projections of trend are often quite accurate (and usually more accurate than projections generated by more sophisticated models). Following this path, one class of studies simply measures the ratio between enrollments of various types and the total population in the relevant age group (18-21 or 18-24 in the series published by the U.S. Office of Education) and seeks to discover trends in this ratio over the recent past. [6, 5] But projections of trend based on such measurements encounter serious difficulties if pushed very far into the future. As we discovered, for example, examining the data for the period 1919-1964, the substantial rise in such a ratio was almost entirely accounted for by the increasing proportion of high school graduates in the relevant age group. Given the requirement of a high school diploma or its equivalent as a

minimum condition for college admission, the use of such ratios for forecasting purposes would have to be qualified by consideration of the circumstances governing high school graduation ratios as well as those affecting decisions to enroll by high school graduates. The sociological and social-psychological literature provides a full measure of studies directed at the latter set of circumstances: decisions to enroll. Usually based on surveys of various cultural and demographic characteristics of individuals or families, these studies stress the importance of college attendance for upward social mobility. The most important variables they have succeeded in isolating include the social class origins of students and the educational attainments of their parents. [3, 7, 4] Blaug's summary is to the point: "...the single most important sociological finding is that something like an inter-generation ratchet-effect tends constantly to shift the individual demand curves for education irreversibly to the right as succeeding generations achieve over higher terminal education ages." [1-170] He goes on to argue that this effect should be viewed as independent of and presumably additive to the effect of the growing proportion of those individuals meeting the minimum eligibility requirements by high school graduation.

By contrast with these studies, conventional demand theory proceeds by attempting to explain changes in the decision to enroll as

a function of changes in income and relative prices with "tastes" held constant. It hypothesizes a negative relationship between the number of enrollments demanded and the price of an enrollment and a positive relationship between enrollment and income. If one attempts to test hypotheses based on demand theory, however, a number of problems are encountered. One of the most crucial arises from the nature of the product and its impact on the relevant price variable. If higher education is viewed as an investment, an appropriate decision model would compare a stream of future anticipated earnings flowing from the educational attainment with a stream of present costs including opportunity costs. The resulting internal rate of return may then be compared with some appropriate market and, if higher than the market rate, the educational investment will be undertaken.¹ Following this approach, Blaug has drawn a private demand curve for education in which the amount of education is a negative function of a price variable, γ_b/γ_e , in which γ_b is a market rate on alternative investments and γ_e is the internal rate of return on investment in education. In other words, given a value for the alternative rate of return γ_b , and assuming constant tastes additional education will be demanded out to the point where γ_e , the internal rate of return, has fallen sufficiently

¹This abstracts from imperfections in the capital market and from uncertainty. For a more complete discussion see [5].

to bring it into equality with γ_b . [1-170] On the other hand, a model viewing education as a consumer good could substitute a rather simple price variable for this complex rate of return expression. The corresponding decision model would require the consumer, again with "tastes" given, to compare the price of the education with the prices of other alternative objects of his consumption. As Siegel and I have elaborated elsewhere [5], it is possible, given the almost insurmountable data requirements for adequate specification of the investment model, to reconcile the simple demand model, using relative price and income variables, with both the investment and consumption approaches. Such a model then may be used to test the assumption of constant tastes and, hopefully, to provide estimates of price and income elasticities. In other words it provides an alternative to the sociological approach with its almost exclusive focus on the explanatory role of tastes and changes in tastes. What the sociologist identifies as variables, the economist is inclined to lock up in the pound of ceteris paribus.

The results of our rather simple test suggest that the economic demand model can be useful. In order to eliminate the influence of the most significant shift parameter over time, namely the rise in the proportion of those aged 18-24 who became eligible for college enrollment during the period studied, we defined demand in any given year as the proportion of those 18-24 with high school

diplomas and not in the armed forces who chose to enroll in a four-year institution of higher education. By defining demand in this way we could focus on the relative influence of price, defined as tuition cost relative to an index of all consumer prices, and household real income. That part of the variation in our demand ratio which price and income could not explain could then be ascribed to changes in tastes---in particular to what Blaug had described as the inter-generation ratchet effect arising from the over-higher educational attainments of successive generations of parents. While the test included only the few scattered years for which tuition data could be obtained beginning with 1927 and ending with 1963, the conclusions were stronger than we had expected. First of all, as already noted, there was no apparent trend in the value of the enrollment ratio over the entire period. Furthermore, some 87% of the variations in the ratio that occurred within the period was explained by variation in price and income. The signs of the coefficients of price and income were negative and positive respectively, indicating consistency with the simple demand model.

In examining the very large increases in college enrollments that have occurred since 1919 our research would tentatively suggest the following generalizations: There seems to be a rather constant and strong preference for higher education in the part

of the population, but Blaug's anticipated ratchet effect has not manifested itself. Over time the rise in the proportion of the college age population possessing high school diplomas makes it potentially possible for this persistent taste for higher education to be satisfied. While supply does not seem to have been a limiting factor, price and income constraints do operate. We note, for example, that the enrollment ration fell sharply through the late 1920's and 1930's as real disposable income per household fell and tuition costs rose relative to other prices. Again, when household income rose in the postwar period, the implied rise in the enrollment ratio did not occur since relative tuition costs also rose.

While the results apply to the total demand for higher education in the U.S. and not to the particular enrollment prospects of an individual institution they do provide some insights for educational planners. They do, in Blaug's words, help "to separate the available information into distinct boxes so as to indicate its relevance." Finally, they point out areas for further research and study so as to separate still more information into still more distinct boxes.

As already noted none of the research to date has shed much light on the investment versus consumption aspects of higher education. We can find only hints. Aside from a general feeling that higher education is desirable for occupational and income generating

reasons, surveys of public attitudes toward higher education do not suggest anything like the careful comparison of rates of return implicit in the investment demand model. A study by Angus Campbell is a good example. [4] Asking a sample of households in May, 1963, to choose from a list of reasons why it was important for their sons and daughters to go to college, he was able to isolate two dominant reasons---one clearly associated with a generalized version of the investment model, the other with the consumption model. For their sons, 72% of the respondents chose the investment alternative, training for a good job after graduation, while 21% felt that an increase in the student's understanding of the world and himself was the most important reason. When the respondents were classified by income level and educational attainment, however, the importance of the consumption alternative was found to be positively related to both of these characteristics. Parents with a college degree in the over \$7500 income class felt that the consumption objective was more important than investment in education, with 55% choosing the increased understanding alternative and 44% choosing the training for a good job alternative. Thus, those with presumably the best personal knowledge of the nature of a college degree and its income benefits chose to view higher education as primarily a consumer good and only secondarily as an investment good. The lower the family income and the less

the educational attainment of the parent the more important the investment good aspects of higher education were expected to be. When these findings are considered along with the alleged importance of parental educational attainment as a determinant of the preference for college enrollment (a finding also borne out by the Campbell study) they suggest that higher education may come to be viewed more and more as a consumer good. Thus, while the professional educator, educational administrator, and education-oriented economist have become more and more attached to the investment model as a result of the impact of rate of return studies, the attitudes of those members of the public who have the highest probability of sending sons and daughters to college could be tending the opposite direction. It is interesting also that the one study with which I am familiar which extends rate of return analysis beyond the 16th year, by John McKean of the University of Washington [12], shows a sharp drop in the rates associated with graduate education. If the apparent marginal rate of return on graduate education is doubled to allow for social benefits not appearing in the income of the student, McKean finds that investment in graduate education still fails to provide a 5% rate of return. In part this is traceable to the steadily rising opportunity cost element in the calculation---and is consistent with

the downward trend in most rate of return calculations after completion of the primary grades. But it also suggests that graduate degrees may be sought as a key for entering a particular life style rather than as investments designed to yield higher money incomes. The attitudes of student activists involved in recent campus demonstrations also suggest a growing rejection of the vocational or investment orientation by the students themselves.

As I suggested earlier the fragmentary evidence we have indicates that the higher educational product is a rather complex package of characteristics---varying from college to college, from discipline to discipline, and from level to level. Clearly we need more disaggregation, with specific studies designed to isolate these various characteristics and their relative importance in enrollment decisions. The investment-consumption dichotomy provides only two among very many possible "boxes" into which such characteristics could be fitted. Clearly also, the usefulness of demand studies to the planning problems of individual institutions of higher education would be much enhanced by such disaggregation.

Demand Analysis and Educational Planning.

This brings me, finally, to the planning implications of demand studies. Actually, as noted earlier in my paper, the

economic analysis of the demand for higher education is but one facet of a broader approach which proceeds by viewing the educational institution as a firm within an industry or set of industries made up of such firms. By its very nature such an approach runs counter to attempts at comprehensive and sophisticated planning models for entire educational systems. The concept of demand itself ---as a schedule of possible enrollment levels associated with different price (tuition) and income levels---is at odds with the definition of demand used in the planning models. In an excellent paper presented in last year's conference here at Tallahassee, Russell Davis describes the manpower approach to demand used in several of the conference papers and in other studies which stress comprehensive educational planning. "In the newer planning models," he said, "there has been much stress on the so-called economic demand for education, i.e., workers for some future year classified according to education-training levels. The education-training levels are derived from the occupational structure of the work force, which is related to the activity sectors of the economy which is related to the total output of the economy." Davis goes on to comment that "other demands, political, social, and cultural are alluded to in plans but the most explicit analysis is directed to estimation of the economic demand, perhaps in the mistaken notion that the economic demand is the most straight-forward

estimate to make." [8-71] What I would like to do is to very briefly contrast this manpower approach with the kind of planning implicit in the firm and industry approach out of which our demand studies have evolved. What is at stake in such a comparison are quite different views as to the nature and goals of higher education and the effectiveness of the market mechanism in the economy, as well as the nature of the link between higher education and the economy. The assumption that resource allocation patterns in the economy are generally responsive, perhaps with significant lags, to changes in relative price patterns carries over into a view that human resources are not highly specialized and that people with various types of original training can perform the same job and that a person with a specific skill can transfer from one job to another as relative labor demands, supplies and prices alter. This flexible economy view leads to the conclusion that the link between education and employment is a loose one, that education should be general rather than highly specialized and that there is interaction between the labor market and educational demand and supply in the sense that, for example, a relative shortage of highly skilled and educated manpower can be accommodated in the short-run by lowering educational requirements and hiring the less-skilled, leaving time for educational patterns and manpower supplies to adjust in the long-run. This

implies that decisions about higher education can safely be left to the more or less informed choices of potential students and individual institutions of higher education which can adapt their programs to the market in analogy to business firms. Such a view is not incompatible with the evidence of a competitive rate of return on investment in higher education even though it does minimize the importance of being exactly right about the kinds and quantities of highly specialized technical training needed within higher education. It has become a commonplace to note that the measured rates of return on additional education are a joint result of the education itself, the degrees and diplomas to which it leads, the superior employment doors that such degrees and diplomas (for whatever reason) seem to open, and the disproportionate share of on-the-job training and learning experiences that occur in those favored kinds of employments.

On the other hand, one can argue along with the manpower planners that the economy is highly inflexible and prone to structural maladjustments. Resource allocation patterns cannot adjust smoothly to changes in the pattern of final demands and prices since production processes are characterized by fixed input coefficients and human resources are so highly specialized as to be non-transferable from job to job and skill to skill. In

such an economy the link between jobs and education is a very precise one with uniquely job-specific educational requirements dictated by the structure of employment which is in turn dictated by the structure of production. Relative shortages or surpluses of particular types of trained manpower, if not anticipated and thus avoided by the prescient adaptation of the educational pattern, will persist and lead to sharp, discontinuous shifts in relative earnings which cannot be overcome by market adjustments in the short-run. In this kind of economy decisions about education may be too critical to be left to individual students and educational institutions, hence the implied need for prescriptive and comprehensive planning.

Happily, both of these views, which clearly lie on either side of the truth, are fully compatible with better planning on the level of the individual institution of higher education itself and would support the stress that several of the papers at this conference have placed on the use of planning and systems analysis at the level of the educational firm. At the same time, a consideration of these views reminds us that effective applications of planning and systems analysis to the educational firm require some clarity about educational goals and the nature of the educational product. Clearly these objectives cannot be separated from the views held as to the nature of the relationship between

education and the economy and the economic, social and political context of that relationship. For example, the McKean study [12] suggests that we may be experiencing a secular decline in the rate of return on investment in college education while the return on primary and secondary education has held up rather well. Taken together with a possibly growing importance of the consumption component in higher education this raises some important questions with regard to tuition and subsidy policy in higher education, and the allocation of additional public support between higher education and, for example, pre-school and kindergarten education.

As one can anticipate from the nature of the work we are doing at Oregon, I am not optimistic about the potentialities of the rigid manpower planning approach and the views as to the nature of higher education and its role in the economy implied by that approach. Perhaps the truth lies more in the opposite direction. Blaug's strictures seem reasonable to me. "On the one hand," he says, "manpower planners tend to disregard potential substitutabilities in the utilization of educated people, thereby implying considerable rigidities in the economic structure of production. This means that any errors in forecasting will lead to irremediable wastes of resources. But, on the other hand,

they argue that even crude estimates of future manpower needs can serve as useful guides, apparently because errors in forecasting will not lead to serious wastes." But, as he goes on to argue, "this suggests that the economic system is fairly flexible, so that an increase in the supply of highly qualified manpower automatically stimulates demand by raising minimal hiring standards." This conclusion is, as he states, "like having your cake and eating it." [1-178]

From the planning point of view, perhaps the best justification for the continuing research we are all doing is that it will help to clarify the larger questions of policy that loom up out of these contrasting views of education and its relation to the economy, and, in this way, prevent us from becoming mere planning technicians who would permit the means to determine the ends.

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